HYGIENE

BY

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PREFACE.

The problems that arise in the study and practice of hygiene are many and diverse; some are medical, some moral, some political, others mechanical, many are engineering and all are economic problems. The time allotted to the study of hygiene in any school cannot be sufficient to master more than a small portion of the subject. Even the portion of hygiene which forms a part of the medical curriculum is so vast that the maximum time allotted to its study is barely sufficient for one to gain an intelligent conception of fundamental principles.

Text books on this subject prepared for medical students are cumbersome with details of military and public-service hygiene, ship disinfection, descriptions of various systems of sewage disposal that are seldom used and of questionable value, and other things of minor importance that make perusal difficult for those who must learn the vitally important facts concerning food and water supply, garbage and sewage disposal and disease transmission in civil life, and learn it well in a limited time.

The aim in presenting this book is to supply those, who have a multitude of duties in addition to the study of hygiene, with concise information on the most important problems that confront every physician frequently, and every layman, sometime.

In a general way this book conforms with lectures given on Hygiene in Jefferson College and the writer is indebted to Professor Rosenberger for his generous aid and invaluable advice and criticism during the time of its preparation. For the sake of brevity some topics considered in the lectures referred to, have been omitted or abridged; a few have been enlarged upon and the chapter on sex hygiene, procreation and legislation, bears no relation to those lectures.

The following works have been freely consulted and are recommended to those desiring more extensive information on the subjects treated:

TREATISE ON HYGIENE, J. L. NOTTER. Published by Churchill, London.

PRACTICAL HYGIENE, L. C. PARKES. Published by Blakiston's Son & Co., Philadelphia.

SANITATION, GEO. M. PRICE. Published by Wiley & Sons, New York City.

WATER SUPPLIES, SAVAGE. Published by Blakiston's Son & Co., Philadelphia.

PUBLIC WATER SUPPLIES, TURNEAURE & RUSSEL. Published by Wiley & Sons, New York City.

SEWAGE PURIFICATION AND DISPOSAL, J. J. COSGROVE. Published by Std. Sanitary Co., Pittsburgh.

SEWAGE, A. P. FOLWELL. Published by Wiley & Sons, New York City.

THE SUPPRESSION OF TUBERCULOSIS, E. VON BEHRING. Published by Wiley & Sons, New York City.

MEDICAL EXAMINATION OF SCHOOL CHILDREN, KELYNACK. Published by S. King & Son, London.

PARENTHOOD AND RACE CULTURE, SALEEBY. Published by S. King & Son, London.

PRINCIPLES OF HYGIENE, D. H. BERGEY. Published by W. B. Saunders Co., Philadelphia.

PROBLEMS OF THE FEEBLE-MINDED AND MENTAL DEFICIENCY. Report of The Royal Commission on The Care and Control of The Feeble-Minded, England.

Publications of The U. S. Marine Hospital and Public Health Service, Washington, D. C.

Publications of The U. S. Department of Agriculture, Washington, D. C.

SYSTEM OF MEDICINE, ALLBUTT AND ROLLESTON. Published by Macmillan Co., New York City.

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CHAPTER I.

PERSONAL HYGIENE.

Those principles which concern most intimately the habits and body of the individual rather than his surroundings and environment, constitute what is called Personal Hygiene.

Exercise and training, to be efficacious from a hygienic standpoint, must not only affect the voluntary muscles, but every organ and tissue of the body.

Healthy function of body tissue can only be maintained by more or less constant use. Parts or organs which are not exercised, waste and lose power to functionate just as in disease.

By training, organs can acquire extraordinary powers; the scope and accuracy of vision may be extended to a marvelous degree; sensitiveness to sound may become exquisite; the sense of smell very acute and the tactile sense wonderfully delicate and discerning.

When muscle contracts the flow of blood is increased; the larger amount of air taken into the lungs, the more oxygen absorbed by the blood and the more carbon dioxide eliminated. The average absorption in twelve hours amounts to 708.9 grammes, while during work it reaches 954.5 grammes. The amount of carbon dioxide eliminated during rest is 911.5 grammes. And during work it is 1284.2 grammes.

TRANSPIRATION.

Transpiration is also promoted by muscular exercise, and in this way some of the effete matters are removed from the system, being held in solution by the sweat, and by it carried through the skin, thus helping out the kidneys. Urine is lessened in amount by reason of the activity of the lungs and skin.

Over-exertion must be guarded against, as it tends to make the heart weak or irritable and tends to cause hypertrophy or some serious disease of the organ.

BATHING.—The most important sanitary object of bathing is cleanliness, it also stimulates the functions of the skin. Cold bath from 4 to 24 degrees C.; tepid bath from 24 to 30 degrees C.; warm, from 30 to 38 degrees C., and hot bath from 38 to 43 degrees C. Tepid, warm and hot baths are used principally as cleansing agents or therapeutic measures. They cause dilation of the cutaneous capillaries, diminish blood pressure and reduce nervous excitability. The hot bath is also employed to restore warmth to the body in cases of shock; to remove the immediate effects of exposure to low temperatures and to relax spasms. Cold baths are used not merely for cleansing effects, but principally for their stimulating effect. Reduction of body temperature in fevers and heat stroke is accomplished by the cold bath.

Sea bathing is the most stimulating. This is due to the revulsive effect of the waves and breakers, the saline constituents of the water and the mental and physical effect of the air and sunshine.

Precautions.—Avoid bathing within two hours after a meal; avoid bathing when exhausted or fatigued from any cause; avoid bathing when the body is cooling after perspiration; avoid bathing in the open air altogether, if after having been a short time in the water, there is a sense of chilliness, with numbness of the hands and feet. Bathe when the body is warm, but lose no time in getting into the water. Avoid chilling the body by standing undressed on the banks or sitting in a boat after having been in the water. Do not remain too long in the water. The vigorous and strong may bathe early in the morning before breakfast, but the young and weak should bathe two or three hours after a meal, usually in the forenoon. Giddiness, faintness or palpitation of the heart induced by bathing is a sign of abnormality, and is an indication for medical examination.

One of the most serious dangers of cold bathing is the tendency to nausea and vomiting if the stomach contains much food. Some cases of drowning, attributed to cramps,

are undoubtedly due to this cause. In drowning, death takes place by asphyxia. Respiration is arrested by submersion of the head, the carbonized blood gradually poisons the system and the heart ceases to beat. Artificial respiration should be carried on in all cases of drowning for at least one hour.

Purification of water in bathing tanks is effected by adding hypochlorite of lime. One part of available chlorine to two million parts of water will keep it practically sterile for four days.

CLOTHING.

The primary object of clothing is to protect the body against the injurious influences of heat, cold and moisture; secondly, it is to satisfy the moral sense of propriety.

Bodies radiate or absorb heat accordingly as they are surrounded by a medium having a lower or higher temperature than themselves; to avoid chilling, clothing must be worn, and it may also be worn to protect the body against great heat or the injurious effects of light.

Cotton seems to be the best for summer as well as linen, on account of the conduction of heat. Wool is a poor conductor of heat, and hence is recommended for winter use.

White goods seem to absorb fewer heat units than any other color, as experiments by Pettenkofer show.

Clothing should be made to fit properly, and should not compress organs, obstruct the circulation nor restrain muscular movements. Corsets, belts and circular garters are condemned.

Dyes used for articles of clothing may be poisonous to the skin, producing troublesome eruptions, and even ulceration of the legs from stockings.

Cleanliness in relation to clothing is important. Excretions are absorbed by clothing, and hence frequent changes or washing is necessary. The sewing up of children for a whole season cannot be too strongly condemned. The amount of clothing is varied according to the season of the year and sensations of each individual. Changes from light to heavier clothing, and vice versa, should not be too sudden.

Shoes deserve careful consideration. They not only protect the feet from heat, cold, moisture and bruises, but prevent contamination and infection by the legion of bacteria, insects, worms and other nocuous creatures which infest soil and water. Shoes which do not fit the feet may cause deformity and impairment of the power of locomotion. Specially constructed shoes may correct certain deformities of the feet and support weak parts.

CARE OF THE MOUTH AND TEETH.

A normal mouth, which contains a perfect set of teeth, is self-cleansing and requires no attention. Unfortunately, such an ideal condition is rarely observed in civilization; hence it is necessary to clean the mouth by washing the teeth. Normally, the saliva and buccal secretions are alkaline and the teeth and mucous membrane are bathed by alkaline fluids. When particles of food lodge between irregular teeth they decay, and such decomposition makes the mouth acid, favors the luxuriant growth of bacteria and so endangers health and injures or destroys the teeth. Certain diseases, such as diphtheria, pneumonia, typhoid fever and tuberculosis of the respiratory tract, cause marked alteration in the quantity and chemistry of the secretions. In these conditions, unless carefully and frequently washed, the mouth becomes dry, the mucous membrane fissures and ulcerates, the tongue swells and becomes painfully tender, myriads of bacteria develop, the breath is offensive and the lips become a mass of ugly sores.

The healthy should brush their teeth to clean them after each meal. Many persons brush their teeth improperly. With the possible exception of magnesium peroxide, pastes or powders should never be employed to clean the teeth. Plain water, or slightly alkaline solutions, are preferred. The tooth brush should have soft rather than stiff bristles, and when not in use should be protected from contamination. To clean the teeth properly it is just as necessary to brush the back teeth as it is to brush the front, and the inside as well as the outside. In many instances the rhamus of the mandible is so close to the last molar teeth of the upper jaw that they can only be brushed by inserting the brush upside down,

when the mouth is wide open, and then sweeping it around the tooth. For this reason the wisdom teeth are unconsciously neglected by many and are the first to decay.

RECREATION.

Every mental effort and muscular exertion consumes tissue; to counterbalance this, rest and recreation are necessary. Before maturity, provision must be made for growth in addition to the replacement of consumed tissue. For the average adult, about eight hours' sleep daily is essential. Personal peculiarities, occupation, climatic conditions and environment necessitate some individuals taking more than eight hours' sleep, and permits others to do with less. Children require more sleep than adults, and suffer more than do adults from the loss of it. In addition to sleep, some people must have other forms of recreation, this is especially true of children and neurasthenics. Continuous mental or physical exertion for hours at a time is detrimental to children: there should be frequent periods of relaxation whether at work or in school.

LABOR.

A fair day's work for an adult may be said to be equivalent to 300 foot-tons, a hard day's work to 400 foot-tons, and a very hard day's work to 500 foot-tons. The latter is about the amount of work performed by a soldier of average weight marching at ease with his kit, twenty miles over a level surface, at the rate of three miles per hour.

Those whose work is mental rather than muscular, and those who do not work, require exercise, such as walking, riding, rowing or gymnastics.

SELECTION OF HABITATION.

Altitude, soil, water supply, air, light, windows, southern exposure. These same should be considered in selecting, constructing and using schools, factories, etc.

FOOD.

Foods are substances which when taken into the body are digested and assimilated, sustaining the process of life,

promoting growth and preventing the destruction of the organized constituents of the body. This definition excludes creatin, creatinin and other so-called meat extractives, also thein and caffein as they neither build tissue nor yield energy.

Man is omniverous and water, salts, proteids and fats are absolutely necessary to his existence; not one of them can be dispensed with for a prolonged period without illness or death resulting.

Water. (See page 45.)

Salts.—Inorganic salts are necessary to the preservation and proper construction of tissue.

Proteids.—Organic nitrogenous material, either animal or vegetable, is a necessary constituent of the food of man.

Fats.—The organic non-nitrogenous or carbonaceous principles of food are supplied by fats or carbohydrates, sugar and starch. Voit has shown that 17 parts by weight, of starch are equivalent to 10 parts of fat as carbonaceous or oxidizable food.

PHYSIOLOGY OF NUTRITION.

Body heat and muscular power are forms of energy. They are developed from the energy which is latent in food taken into the stomach. The changes which foods undergo in the body liberates their latent energy and transforms it into heat, nervous and muscular energy. In a rough way the process is comparable to the transformation of the latent energy of coal and water into active steam which we are familiar with as seen in the steam engine. For the consumption of food in the body and fuel in the furnace oxygen is essential and it is supplied by the air. Air is supplied to the furnace by its draught and to the body by respiration. When the fuel or food is oxidized, be it meat, wood, bread or coal, its latent energy becomes kinetic energy, in the form of heat and power.

As various kinds of coal differ in the amount of heat given off per ton, so various kinds of food give off different amounts of energy. In other words, as various coals have different fuel values various foodstuffs have different food values.

The unit of measure for food value is the calorie. A calorie is that amount of heat which is required to raise the temperature of one gramme of water one degree Celsus.

The caloric value of the different foodstuffs has been estimated as follows:

Protein 4.1 calories per gramme or 1859 per lb.

Carbohydrates 4.1 calories per gramme or 1859 per lb.

To calculate the caloric value of food, **multiply** the number of grammes of proteins by 4.1, the number of grammes of carbohydrates by 4.1, the number of grammes of fat by 9.3.

Protein.—Common articles of food which are rich in protein are: Lean meat, gluten of wheat, barley, white of egg and curd (casein of milk). These nitrogenous substances form tissue.

Fats or **Hydrocarbons** contain a proportion of O less than sufficient to form H_2O with H present. **Foods** of this type are fat of meat, butter, oline, cotton seed and other vegetable oils, corn and wheat; these are non-nitrogenous.

Carbohydrates are substances containing oxygen in the exact proportion necessary to form water with the H present. This non-nitrogenous group includes sugars and starches.

Mineral Matters, (ash) or salts which are necessary articles of diet, are phosphates of lime, potash and soda. These share in forming bone and assist in digestion; they are non-nitrogenous.

Physical exertion increases the consumption of fatty principles. In mental work less carbohydrate material is consumed than during physical labor. In youth the processes of combustion (production CO_2) go on with greater rapidity than after adult life is reached. For this reason young persons rarely get fat, the fat producing food being burnt up in the body by the greater metabolic activity of the young cells. Fats and carbohydrates should form a relatively larger portion of the diet of young persons than of the matured. Low external temperature causes a greater and more rapid consumption of fat than high external temperature. During febrile conditions the destruction of stored up fat in the body, the wasting away, is a process of auto-nutrition, the consumption of body fat serving the person in lieu of other food, hence the importance of supplying fat and fat-producing food in chronic febrile diseases.

CHAPTER II.

MILK, BUTTER AND CHEESE.

Milk is one of the commonest articles of food and on account of the relationship of milk to the diseases of children it requires close study. Different kinds of milk are imbibed as food; cow's, goat's, mare's and deer's milk are all used.

Cow's milk is a watery solution of sugar, mineral matter and proteids, which carries in suspension fat.

The fat of milk consists of glycerides of ten different fatty acids,, five of which are volitile and five non-volitile. Milk should contain from 3 to 4% of fat. Upon standing, milk shows an upper layer which consists mostly of fat as well as other constituents. In watered milk the fat rises quickest and the larger fat globules always come to the surface first, while of the smaller globules some may not rise at all. The last milk from the udder, or strippings, is richest in fat, also in bacteria.

Milk sugar is changed by heat to lacto caramel.

Proteids.—Of the proteids in milk about 80% is casein or caseinogen which is intimately combined with calcium phosphate. Albumens form about 15% of the proteids.

Milk sugar or lactose when undergoing disintegration produces lactic acid. A number of bacteria are capable of inducing this change—bacillus acidi lactici, streptococcus lactis of Kruse, bacillus lactis aerogenes and bacillus coli communis are all capable of souring milk. The presence of lactic acid in milk hastens its coagulation. Only a small percentage of bacilli in milk are lactic acid bacilli and these are eventually destroyed by the product of their own development—lactic acid.

The source of the lactic acid bacillus is undoubtedly from the air and dust shaken from animals, as the examination of the teats and glands of freshly slaughtered animals failed to reveal them.

Mineral matter occurs in milk as phosphates, chlorides of potassium, sodium, calcium and magnesium and there is also a slight trace of iron. The phosphates predominate over chlorides. The ash of milk does not represent the true mineral content, for in the process of incineration some of the constituents are altered. For example, citric acid occurring in small amounts in normal milk will appear in the ash as carbonic acid in combination.

Solids of Milk.—Protein, fat, sugar and ash comprise what are designated as milk solids. The sugar, protein and mineral matter are solids not fat. These latter with the water are known as the milk serum.

Protein of individual cow's milk varies from 2% to 6%. The specific gravity of milk is taken by a lactometer. It should be taken at 60° F. (15.6° C.). The specific gravity of pure milk varies from 1.029 to 1.035, it averages 1.032. High gravity with high fat content indicates a rich milk. High gravity with low fat content indicates a poor milk or skimmed milk. Low gravity with high fat content indicates, "Top Milk," i. e., that which rises to the top of a container allowed to stand undisturbed for several hours. Low gravity with low fat content indicates a watered milk.

The reaction of milk is said to be amphoteric—acid to litmus and alkaline to turmeric—when fresh. On standing, lactic acid gradually forms from the sugar; this causes the alkaline reaction to disappear, and the milk is distinctly acid. Human milk is normally alkaline; that of carnivora acid. When cow's milk is acid, an acidity of 0.18%, calculated as lactic acid, should be the maximum.

Milk may be of different colors, blue, violet, yellow or red, due to the action of certain bacteria. Bacillus cyanogenes produces blue color in milk, but in no other food. When milk is red it is usually due to bacillus prodigiosus or bacillus lactis erythrogenes; blood may impart a tinge of red to milk and possibly an excess of an herb like madder in the feed may also do it.

Ropy milk, as the name suggests, is milk which contains stringy or ropy shreds, which will hang from a dipper with-

drawn from the can. This condition appears not sooner than twelve, but sometimes as late as thirty hours after milking. Cream and skimmed milk may also be ropy. Ropiness most frequently occurs in milk that has stood undisturbed for several hours. It is caused by the bacillus lactis viscosus, a non-pathogenic organism, and is not an indication of disease in the cow from which the milk was obtained. Bacillus lactis viscosus occurs in stable dust, air and water. Rinsing cans with unboiled water at night without scalding, or some other unsanitary procedure, is usually responsible, but ropy milk is not necessarily harmful.

That sour milk, or the organisms which sour it, are harmful to the average adult cannot be maintained. Some sour dairy products are staple articles of food, as cheese and buttermilk. Metchnikoff has gone so far as to recommend a diet of sour milk as a cure for intestinal disturbances and an aid to longevity.

The taste of milk varies according to the feed. Certain substances, such as garlic and young grass, impart a distinctive flavor, which is repugnant to some, but not harmful.

Colostrum is the lacteal secretion of the first few days of lactation. It is yellow, somewhat viscid, has a strong odor and acid reaction. In it the content of casein is about normal, but its sugar is dextrose, not lactose, and rennet will not coagulate it, or at most, coagulates it imperfectly. Colostrum from the cow is not fit for human food, and the Federal law prohibits the use of milk from fifteen days before calving until ten days after.

Boiling milk causes greater coalescence of the fat globules, changes in the character of the sugar, coagulation of lactalbumin and destruction of micro-organisms and ferments. The scum which forms on the surface of boiled milk occurs in consequence of rapid evaporation. It is composed of fat, casein and lactalbumin. Boiled milk keeps better than raw milk, but is slightly less digestible. Sour milk is more easily digested than either, and, according to Metchnikoff, tends to prolong life.

Milk may undergo a peculiar form of decomposition, resulting in the production of an intensely violent poison—

tyrotoxicon--which is a benzene derivative. This change, fortunately uncommon, does not betray its existence by any sign at the time the milk is ingested. It gives rise to milk poisoning, ice cream poisoning and cheese poisoning, the symptoms of which are nausea, vomiting, cramps, collapse, occasionally diarrhea, and sometimes death is the result. Such poisoning is termed Glactotoxismus.

Apart from tyrotoxicon milk, milk may become poisonous as a result of cows eating poison ivy or artichoke. Cows develop a disease called trembles after eating poison ivy, and their milk will cause pain, nausea, vomiting, constipation and subnormal temperature in man. Boiling destroys this poisonous property in milk.

DISEASES TRACEABLE TO MILK—Sporadic cases and epidemics of enteric fever, diphtheria, scarlet fever, cholera, tuberculosis and gastro-intestinal infections have been traced to milk.

BACTERIA PRESENT IN MILK.—Milk as received by city consumers usually shows from 500,000 to 5,000,000 colonies of bacteria per cubic centimeter. Many different kinds of bacteria may be found; those most commonly present are staphylococci, bacillus acidi lactici and moulds. Streptococci, tubercle bacilli, bacillus coli communis, actinomyces, bacillus prodigiosus, bacillus proteusvulgaris, bacillus lactis aerogenes, sarcinae, bacillus anthracis, bacillus typhosus and the spirillum of cholera may occur in milk and have been found there.

The number of bacteria depends upon the degree of cleanliness observed in milking, handling and shipping, upon the rapidity with which it is cooled, the temperature at which it is kept and its age. Milk cows should be well groomed, stabled in clean barns and milked by clean, healthy hands. Milk should be collected in steril cans, rapidly cooled, kept below 15°C. and delivered to consumers before it is twenty-four hours old. Under such circumstances, milk shows less than 20,000 bacterial colonies per c.c.

Skimmed milk is that from which the cream has been removed. It should contain not less than 9.25% of solids.

Condensed milk is prepared by evaporating milk to about one-third or one-fourth its volume in vacuum pans. The addi-

tion of cane sugar increases its keeping qualities. It must contain at least 28% of milk solids of which not less than 27.5% is milk fat.

Koumiss and Kefir are fermented preparations containing lactic and carbonic acids and a small amount of alcohol. They are produced by the action of micro-organisms which induce fermentative changes and bring about a partial conversion of the proteids to albumens and peptones. Koumiss is generally made from mare's milk and Kefir from cow's milk. Lacto-bacillen, Vitalac, etc., are milks fermented or soured by the action of certain bacteria.

Cream obtained by skimming, ordinarily contains 16 to 24% of fat, while that separated by the centrifugal machine contains 20 to 50% or more. The keeping quality of milk depends upon its cleanliness and the temperature at which it is kept. The less it is contaminated the longer it will keep; likewise, the colder it is the longer it will keep.

Cold is the preferable preservative for milk. Frozen milk or that kept near the freezing point will keep for a long time. When used it is found that such milk has suffered no change in its elements, no change in digestibility and no loss in food value.

Pasteurization of milk is carried out in one of two ways:—The flash process, by which it is rapidly raised to a temperature of 150°F., held at that temperature less than a minuate and then rapidly cooled; or the holder process, by which it is raised to 140° or 150°F. maintained at that temperature for fifteen or twenty minutes, then rapidly cooled.

Of the two methods of pasteurization, the holder process is the more efficient. Pasteurization is only of value when it is done shortly before the milk is consumed.

Pasteurization kills from 50 to 90% of the bacteria in milk according to how it is done; but milk allowed to stand in a warm atmosphere after pasteurization, in twenty-four hours will contain almost as many bacteria as it did before pasteurization. Of the bacteria in milk, those which cause souring, are most susceptible to destruction by pasteurization; consequently pasteurized milk does not sour as quickly as fresh milk. Sometimes it becomes putrid before it becomes sour.

Sterilization of milk requires continuous heating under pressure at 248°F., for about two hours. According to some, this causes changes in the sugar and casein which makes the milk less nutritious than it was before sterilization. Sterilized milk in air-tight containers will keep for years.

The preservation of milk by the addition of antiseptics is unnecessary, possibly injurious and unjustifiable. The addition of antiseptics only retards the growth of bacteria, it does not destroy them.

"Preservaline" is a commercial product dispensed for preserving milk. It is composed of boric acid one-third and borax two-thirds. Borax retards the amylolytic action of saliva, both increase gastric digestion in small amounts and retard it in large. To detect the presence of boric acid mix 100 c.c. of milk, 7 c.c. of HCl and saturated tincture of tumeric; evaporate to dryness and add NH_3.

If boric acid is present the residue will turn slate blue and later will change to green. Borax is detected in practically the same way.

Formaldehyde not only retards the growth of bacteria in milk but is germicidal.

One part formalin in 100,000 parts milk prevents curdling for 6 hours.

One part formalin in 50,000 parts milk prevents curdling for 24 hours.

One part formalin in 20,000 parts milk prevents curdling for 48 hours.

One part formalin in 10,000 parts milk prevents curdling for 138 hours.

One part formalin in 5,000 parts milk prevents curdling for 156 hours.

The usual method is to add one teaspoonful of 40% formaldehyde solution to a 40-quart can, that equals about 1:25,000. Formaldehyde alters the character of milk proteids. The casein becomes uncoaguable by rennet, except in thick clots. It makes milk less digestible or wholly indigestible by proteolytic ferments and impairs its food value. Kehner's test is usually employed to detect the presence of formalde-

hyde:—to 10 c.c. of milk in a tube 5 c.c. of concentrated commercial $H_2 So_4$ is added, pouring the latter in carefully so that it falls to the bottom and forms a layer under the milk. If formaldehyde is present a violet ring marks the line of contact.

Leach's Test.—To 10 c.c. of milk in a porcelain dish add an equal amount of commercial hydrochloric acid (sp.g. 1.2) containing 2 c.c. of 10% ferric chloride per liter, heat slowly over flame nearly to boiling, rotating the dish to break up the curd. The presence of formaldehyde is indicated by a violet color. In the absence of this reagent the solution turns brown. One part of formaldehyde in 250,000 parts of milk can be detected before the milk sours; after souring the limit of delicacy is about 1:50,000.

Hydrogen peroxide added to milk will keep it sweet at ordinary room temperature. It exerts the same effect on milk as boiling and sterilization. The presence of $H_2 O_2$ in milk can only be detected within the first few hours after it is added. Not as much as 3:10,000 was detected in milk that stood over night.

Doupouy's test—paradiamidobenzene—is used in aqueous solution. A few gtt. are added to 5 c.c. of the suspected sample and if $H_2 O_2$ is present a strong blue coloration appears.

The dilution of milk requires few words. The abstraction of cream and the addition of water are the commonest methods. Annatto, caramel and anilin are sometimes added to impart a rich creamy color to milk which is deficient in fat. This is easily detected for when pure milk stands for a time it shows different layers having different colors, but artificially tinted milk will not—it is always uniform in color.

Gelatin is sometimes added to milk or cream to thicken it and give it the appearance of containing abundant fat. A great many commercial ice cream manufacturers add gelatin to their product.

Whether milk has been heated or not may be detected by Starch's test:—To several c.c. of milk in a test tube add one drop of weak $H_2 O_2$ (2%) and two drops of 2% solution of paraphenyldiamin, shake thoroughly. If a dark violet color appears immediately after shaking, the sample was not heated, at least not above 175° F.

Sediments in milk consisting of mud, feces, hair, etc., indicate improper handling and gross bacterial contamination. Such milk may contain tubercle and other pathogenic bacilli.

Diseases Traceable to Milk.—A large part of the mortality among bottle-fed children, especially in summer can be traced to gastro enteritis, toxemia and impaired vitality caused by dirty milk. Epidemics of scarlet fever, diphtheria and typhoid have been traced to milk, and there is strong evidence indicating that milk is often the vehicle which carries tubercle bacilli to persons in whom they cause disease.

BUTTER.

Butter is made by the violent agitation of cream until its fat coalesces into granular particles which are then separated from the residual buttermilk, "worked," to express as much of the latter as possible and with or without the addition of salt and coloring matter, formed into prints or pats or packed in bulk in firkins.

Butter made in June has a natural bright yellow color while that made when the cows are stabled and stall fed, with hay, etc., is almost white. Most butter is artificially colored; usually by the addition of Annatto. Annatto is a harmless substance and its use is generally permitted by law.

The flavor of butter is influenced by the character of feed given the cows. Butter made from the milk of animals grazing on young, tender, juicy grass, has a pronounced grassy taste and that from garlic-fed cattle has a flavor of garlic.

The flavor of butter is also affected by salt, its age and conditions of storage. In some portions of the world on account of the absorbing property of butter. they place the freshly made product in proximity to jasmine, violets, tuberoses and other flowering plants so that their fragrance may be absorbed; this is called "Enfleurage."

It is necessary to add salt if butter is to be kept any length of time. Without salt butter soon acquires a cheesy flavor, due to decomposition products. Butter of good quality has but slight odor. That which has undergone common bacterial changes becomes rancid in taste and odor. In

rancid butter, butyric and other acids are liberated, and others, as formic, are formed by absorption of oxygen.

The average fat content of butter is 84%. As in milk, this fat is composed of two groups of fatty acids (glycerides). Of the non-volatile acids, oleic, stearic and palmitic constitute 92.25% of the whole; the soluble volatile acids, butyric, caproic, caprylic and capric, make up the remainder. Butter should not contain more than 15% of H_2O. It is sometimes adulterated by the addition of water or of substances which will absorb water. For this purpose gelatine is added. One gramme of gelatine will take up ten grammes of H_2O, and when mixed with butter in the right proportion will hold water in the above ratio without affecting the consistency of the butter. Glucose has been added to butter for the same purpose and also as a preservative. Aside from the addition of these agents, butter is not much subject to adulteration.

There are various counterfeit products substituted for butter. These have been given many different trade names, as artificial butter, butterine, margerine and oleomargarine. The United States Government says: "All butter or substitutes therefor made to resemble it, containing other fats than cream, shall be known as 'Oleomargarine.'"

Oleomargarine is made from fresh beef suet, which, after being cooled, washed and cut into very fine pieces, is subjected to a temperature of about 110° F. for several hours, in order to separate the fat from the tissue. It is then drawn off and kept for a time at 80° to 90° F., at which temperature the stearin solidifies, and is then separated by pressure from the "Oleo Oil." The latter is churned with milk, or with milk and genuine butter, colored with annatto and treated like butter.

At the present time oleomargarine is made not only from beef suet, but to a much greater extent from "Neutral Lard," a product of leaf lard. Cotton-seed oil is used to some extent, but is not as well adapted as the solid fats. All tainted materials (no matter how slight) must be excluded, and rancid fat cannot be used in the manufacture of oleomargarine. It derives its flavor wholly from the milk or genuine butter incorporated in it. It contains less water, undergoes

decomposition more slowly, and is equally as digestible as butter. Oleomargarine is as clean and wholesome as butter, or more so, and is equally as nourishing.

Renovated, process or hash butter is made by amalgamating lots of butter from various sources; butters which differ in age, color and quality. The manufacturers of renovated butter collect from dairies, creameries, cold storage plants and dealers butter which they have been unable to sell. Some of it is salty, some rancid, some putrid and occasionally a little good butter may be found. This is all put in a vat, melted, purified of its rancidity by washing, colored and re-churned.

Ordinary butter contains millions of bacteria to the gramme. The bacillus of cholera and typhoid have been known to survive several days after implantation in butter. Various observers studying the product for the tubercle bacillus have found it and proved its presence by producing with it tuberculosis in guinea pigs; other observers have searched for and been unable to find tubercle bacilli in butter. It is well known that tubercle bacilli can exist in a viable state for at least eight months in butter kept in cold storage.

Pure butter when held over a flame in a teaspoon will foam quietly and very considerably. It swells up and holds the foam when it is withdrawn from the flame. Renovated butter or process butter may bubble, but does not foam.

Mix a small mass of suspicious butter with an alcoholic solution of $NaOH$, boil and pour in cold water. If it is pure butter a pineapple odor will develop. If it is oleomargarine there will not be a pineapple odor.

CHEESE.

Most varieties of cheese are made from compressed cow's milk, some from ewes' and others from goats milk Milk is used for this purpose either in its natural condition, skimmed or with the addition of cream. The milk is heated to 80° F. or above and curdled with rennet. This coagulation should occur within forty minutes to an hour. The curd is then broken or cut up, the whey drawn off and the curd gathered and covered and allowed to stand for an hour or longer,

which increases its acidity. It is then placed in a press, and when removed the whey and the curd must be of proper consistency throughout. Ripening is carried on by certain bacteria, moulds and enzymes at 70° F., a process of decomposition.

Cheeses, as a rule, contain one-third fat and one-third proteids and the remainder water.

In the adulteration of cheese, lard is sometimes substituted for the proper kind of fat. Lard and skimmed milk colored with annatto and heated to 140° F. in tanks and coagulated in the same way as cheese forms a substitute or counterfeit, called "Filled Cheese." Preservatives may be added to cheese, and principally when it is made from skimmed milk.

Cheese poisoning, due to a ptomaine, tyrotoxicon, causes vomiting, diarrhea, abdominal pain, constriction of the throat, feeble and irregular pulse and marked cyanosis. This is not the only poison that may occur in cheese; others have been found.

Cheeses may be classified as cream, whole milk and skimmed milk cheese, according to its quality. It is also known as hard, medium and soft cheese. There are a number of different cheeses which have special names, such as Edam, Roquefort, etc.

CHAPTER III.

VEGETABLE FOODS.

Under the term "Vegetable Foods," we consider farinaceous seeds, cereals, legumes and preparations of them; fatty seeds and vegetable fats, tubers, roots and herbaceous articles, fruits used as vegetables and fruits in the narrower sense; also edible fungi and saccharine preparations of any of these.

CEREALS.

Wheat is the most nutritious vegetable food. The outer layer of the grain, called bran, is indigestible, poor in food-value and consequently discarded in the milling of flour.

Wheat flour contains about 70% starch, 1.5 fat and 12% proteids. Gluten, the essential ingredient in making bread, forms 80% or more of the total proteids of wheat.

Leavened bread is made by baking a mixture of flour and water, called dough, to which yeast, bicarbonate of soda, sour milk or some similar agent has been added. The process of leavening is as follows: The yeast, or its substitute, causes fermentation and carbonic acid gas is generated, which rarefies or raises the dough. When the dough is put in the oven, heat further expands the gas and baking solidifies the gluten, so that the finished product retains its light, porous structure.

Bicarbonate of soda and other chemicals, called baking powders, which liberate gases in the presence of acids, are sometimes substituted for yeast to leaven or raise bread, because they act quicker; but they are inferior to yeast for this purpose, and bread so raised is inferior to that leavened by yeast.

Without its high content of gluten, wheat could not be made into bread. Protected from moisture, leavened bread remains wholesome and palatable for a long time, but if exposed to moisture it soon becomes soggy and sour. If such

bread is eaten, it is apt to cause excessive gas formation in the stomach and produces disagreeable gastro-intestinal disturbances and affect the health.

Bread less than 24 hours old is harder to digest than older bread. Contrary to general belief, there is little, if any, difference in the nutritive value and wholesomeness of white bread, brown bread and Graham bread. Whole wheat bread irritates the intestinal mucosa, forms a large amount of feces and increases fecal evacuations; for these reasons it is not a desirable article of diet for normal persons, but has a salutary effect where the intestinal mucosa is sluggish and needs stimulation, where additional bulk is desirable in the digestive canal and where constipation must be corrected. Unleavened bread is baked at a higher temperature or for a longer time than leavened bread. It is hard, crisp and keeps well for a long time.

There is a smut called ergot that forms occasionally upon growing wheat and bread made from such wheat, if eaten for a long time produces symptoms of poisoning (ergot).

RYE.

Rye contains nearly the same amount of proteids, gluten, fat and starch as wheat does. Bread made of rye flour is quite as nutritious as wheat bread, but is generally considered less palatable.

CORN, OATS AND BUCKWHEAT.

Corn, oats and buckwheat are all as valuable foodstuffs as wheat, containing about the same amount of proteids, fat and starch. They are prepared for consumption in various ways, but cannot be made into bread on account of their lack of gluten. Some corn, diseased while growing or during the time of storage, when made into flour and eaten, causes a serious disease called pellagra.

The most common form of flour adulteration is that of blending or mixing inferior or cheaper grades with the best and passing it off as the most expensive, as adding rye or corn flour to wheat flour. Such adulteration of flour cannot be considered among the causes of disease.

RICE.

Rice contains about 7.5% proteids, 79% starch and less than .5% fat. It is much poorer in food-value than wheat, oats or corn, and although used as the principal or sole article of diet by millions of people cannot alone supply all the food requirements of man. Most of the rice used is polished in the process of milling, and this has been proved undesirable. A diet of polished rice often causes a serious malady with a high mortality, called Beri Beri. It is said that Beri Beri does not occur if unpolished rice is used. Chestnuts are much poorer than rice in proteids, starch and fat, and are more difficult to digest than any of the cereals. In southeastern Europe chestnuts are used extensively in the making of bread. The starch granules of each of the cereals have a characteristic morphology, and so the nature of the flour can be discovered by microscopic examination.

LEGUMES.

Beans, lentils and peas are similar in composition and food-value. They contain about 25% proteids, 1.5% fat and 50% starch. The high amount of proteids (almost twice as much as wheat) makes them good substitutes for meat. Legumin is the principal proteid found in beans, lentils and peas, which is the characteristic of the group. Legumes are harder to digest than cereals, and some are prone to cause flatulence by the formation of sulphureted hydrogen.

NUTS.

Almonds, cocoanuts, peanuts, walnuts and some other less common nuts contain more than 50% fat, and are rich in other nutritious matter, which gives them a high food-value.

VEGETABLE FATS.

Many vegetables contain a high per cent. of fat, which is highly nutritious. Virgin olive oil is the most elegant and expensive of those commonly used in the preparation of food. It is made from the choicest olives gathered when three-quarters ripe. They are milled sufficiently to crush the pulp,

but not the stones, and then put in piles. Only the oil that drains away without any mechanical pressure is collected. Virgin olive oil has a distinct greenish tint. Most olive oil is obtained by crushing both pulp and stones and expressing the oil by means of pressure.

Cotton seed and peanut oils are quite as wholesome and nutritious as olive oil, but less expensive, and, consequently, are often substituted for or used to adulterate olive oil.

The nature of vegetable oils can be determined with the refractometer and by chemical tests.

TUBERS AND ROOTS.

Potatoes.—Proteids of the potato are chiefly in the albuminous juice. Most of the mineral matter is salts of potassium, and this, too, is almost wholly in the juice. The starch granules are larger than cereal starch granules, and are irregular in shape.

A potato that bakes mealy does so not on account of high starch content, but because of a low per cent. of albumen. A potato rich in starch keeps its shape, and neither cracks nor falls apart beneath the skin. There are three well-defined layers. The outermost is richest in starch and poorest in proteids, but in the innermost these conditions are reversed. The middle layer represents the mean composition of the whole. The loss in boiling is less when the skin is intact.

Potatoes are deficient in nitrogen, and do not constitute a proper ration of themselves, but with foods rich in proteids, such as meats, beans and peas, they are valuable and economical. Potatoes are sometimes poisonous, as the normal potato contains about .006% of solanin.

When sprouting the solanin content is materially increased. In 1892 and 1898 there were many outbreaks of such poisoning in the German Army, which were due to the consumption of completely ripe and sprouting potatoes.

Carrots, beets, parsnips, turnips, oyster-plant and radishes are very poor in proteids, and contain but a small amount of other nutriment. Cabbage and celery are hard to digest; lettuce and cress are easily digested. Cucumbers, tomatoes,

squash, pumpkin and egg-plant contain about 90% of water, and are very poor in proteids, but fairly rich in carbohydrates.

FRUITS.

Bananas, figs and dates contain about 3% proteids and 30% sugar; bananas also contain about 3% fat. These are the most nutritious fruits, and form an important part of the native diet in certain tropical regions. Other fruits are much poorer in nutritive elements, and are chiefly valued for their sugar content.

CHAPTER IV.

CONTAMINATION OF FOOD BY METALS.

Small amounts of metallic salts are present in food either by accident or intentional admixture. The most common are compounds of copper and lead, while the salts of zinc, tin and nickel are occasionally present.

Copper gains entrance through the improper use of cooking utensils of brass and copper and through the employment of salts of copper to give a green color to peas, pickles and other vegetables.

Inferior grades of copper and brass kettles yield small amounts to acid, fatty and other foods allowed to stand therein, especially if the contents are exposed.

Sometimes vegetables are boiled in very dilute solutions of copper sulphate, drained, washed and put in cans or glass jars. It is contended that such food does not retain the copper, that the copper simply acts upon it as a fixative for the chlorophyl. This is contrary to the facts. Copper sulphate does not fix chlorophyl in vegetables treated with it, but is retained by such vegetables. The amount of copper contained in vegetables boiled in dilute copper sulphate solutions is so minute that very little, if any, harm results from eating them.

Portions of lead are of common occurrence in various articles, especially those wrapped in tin-foil or in cans having exposed seams of lead solder. Cooking and shipping utensils may contain only a trace, or as much as 89% of lead. In Germany, tins must not contain more than 10% of lead. Metallic caps on glass jars may be dangerous; patent stoppers of soft drink bottles sometimes yield lead in small amounts. It is quite improbable that the occasional use of canned vegetables containing but a fraction of a milligram in a can will cause serious injury but the continual intake of appreciable amounts of lead is likely to culminate in serious consequences. Avoid acid drinks contained in bottles

with lead stoppers as habitual use may lead to insiduous or sudden symptoms of lead poisoning; wrist drop, toe drop, or neuritis. Traces of zinc may occur in canned foods from the use of chlorides of zinc in soldering. Dried apples desiccated on galvanized iron racks frequently contain zinc but in amounts so small as to be unimportant.

Sulphate of nickel is sometimes used instead of copper for greening peas. Nickel cooking utensils and nickel dishes give off a slight amount to foods cooked in them.

Food is often contaminated with tin, usually the chloride of tin. This is harmless and unimportant.

There is little or no danger from enameled cooking utensils or lead glazed pottery if the firing is done properly. The same may be said of aluminum.

FOOD PRESERVATION.

Foods of a perishable nature are preserved in many different ways but not all methods are applicable to all foods. Freezing and salting, while suitable for fish and meat, cannot be employed with fruit or vegetables, while preservation in sugar syrup is adaptable to fruits, it is not to meats. The methods in general use include low temperature, desiccation, salting, smoking, canning and chemical treatment. In the employment of cold as a preservative, freezing is not essential. For shipping from place to place or for short periods of time, packing in ice is sufficient. Cold storage plants properly constructed, have compartments which may be maintained at any desired temperature down to 6°F. Meats and fish keep for a long time at low temperatures but should not be allowed to freeze and thaw. Eggs and fruit may be kept in dry air at just above the freezing point for many months. The advantages of cold are, that unlike other preservatives it involves neither the abstraction of any constituent of a food nor the addition of foreign matter. Food kept in cold storage retains its natural flavor and suffers no loss in its nutritive value, nor the ease with which it may be digested.

If it is kept in cold storage when removed it should be immediately consumed because such foods soon decay when exposed to dry temperature.

Drying is not so well adapted to meats as to vegetables since it leads to loss of flavor. Dried meats are considerably less digestible than fresh meats. When thoroughly dried and stored both meats and vegetables can be kept a long time, but drying meat does not destroy contained parasites.

In salting, the soluble organic materials are removed in larger part and the fibers become hardened. Salting diminishes the nutritive value and the digestibility of foods.

Canning was known as early as 1804. Canned meats have been found eatable even after forty-four and sixty-three years from the time of canning. Canned foods are sterilized by steam or by boiling and are hermetically sealed.

Chemical preservatives are employed. Some of the commonest are: borax and boric acid, used together or separately; salicylic acid, sodium chloride, glycerin, alum, sodium sulphite, sodium bisulphate, sulphurus acid, formaldehyde, peroxide of hydrogen, sodium carbonate and sodium benzoate.

POISONING CAUSED BY CANNED FOODS.

Vegetables, meats and fish are placed in cans and then sterilized in the autoclave for one-half to one hour at 112° to 120°C., such an exposure kills practically all bacteria; but sometimes the apparatus does not work properly or there is some other slip in the technique, then bacteria subsequently develop, that is followed by the development of putrefactive products. When gas is formed the can becomes blown and a foul smelling gas escapes.

String beans sometimes cause poisoning like botulism and from these vegetables B. Coli, Paratyphoid Bacilli and other organisms have been isolated. Toxins or Ptomains are also produced and these may cause the sudden development of grave symptoms, within an hour after eating. Canned goods often contain bacteria without producing gas. The goods should not be accepted if examination discloses the presence of any bacteria.

In all these foods or vegetables it must be borne in mind that boiling does not always destroy the ptomains as some

resist boiling or heating for eleven hours. Idiosyncrasies to some foods may lead to poisonous symptoms, i. e. rashes after eating berries, fish and cheese, rheumatic conditions; urticaria may result from eating tomatoes and choleraic symptoms may follow the ingestion of grapes. The development of symptoms as a result of personal idiosyncrasies of course is not due to a fault in the food.

CHAPTER V.

FOOD POISONING OR BROMATOTOXISMUS.

Bromatotoxicon is a general term applied to the active agent in a poisonous food.

Bromatotoxismus may be brought about by chemical changes in grain and tubers as when potatoes sprout or when ergot forms on grains of rye. Plants and animals can feed on such substances without ill effect, but man may be seriously injured by them owing to his greater susceptibility.

The flesh of some animals is poisonous during the period of physiological activity of certain glands, though inocuous at other times. Fish which are wholesome food, except during the spawning season, in some instances are poisonous then.

Any food may be contaminated with specific organisms and carry typhoid and similar infections to man.

Cattle are susceptible to certain diseases which afflict man; the meat and milk of diseased animals can transmit disease such as tuberculosis.

Foods of various kinds may be contaminated with saprophytic bacteria which by their growth elaborate chemical poisons, before or after the food has been eaten. This is the most common cause of food poisoning.

Mytilotoxismus commonly causes choleraic symptoms, nausea, vomiting, tenesmus, diarrhea and exhaustion—the onset is frequently sudden and the condition may terminate fatally. Sometimes the symptoms are more purely nervous in character—there is a sensation of heat, itching, urticaria, shortness of breath and perhaps convulsions or asthmatic attacks.

Occasionally the clinical picture resembles acute alcoholic poisoning and is followed by paralysis, and death.

Mytilotoxine, the cause of mytilotoxismus, occurs in mussels. Snail poisoning has occurred in epidemic form when it has been found the snails contained an organism similar

to the bacillus of hemorrhagic septicemia. After eating such snails there are marked disturbances—hematuria, vomiting, diarrhea or constipation, and convulsions or paralysis. Of forty persons stricken in one epidemic five died.

Oysters taken from beds polluted with sewage, contain more bacteria per c. c. than the water which surrounded them. Such oysters may acquire harmful properties just as mussels; they may be contaminated with typhoid bacilli.

Ichthyotoxismus.—Some fish are poisonous at all times; others are during the spawning season. Fish are subject to epidemic bacterial diseases and some fish so affected contain toxins which are poisonous to man.

Poisonous substances used by naturalists to kill fish are also poisonous to man, and if fish so killed are eaten ill effects follow.

Botulism, is poisoning which follows the ingestion of meats, particularly sausages, and is due to toxins formed in them by bacterial growth.

Blunzen, the stomach of a hog stuffed with meat and then cured, is a favorable substance in which bacillus botulinus and other anaerobic organisms grow and liberate toxine. In sausages, blunzer and other things anaerobic organisms grow most abundantly in the centre of the mass,—that portion which is farthest from oxygen; hence the interior of such preparations may produce illness even though the cortex does not.

Kreotoxismus is brought about by eating the flesh of animals dead from certain diseases, or slaughtered while suffering from these diseases. The most important causes of kreotoxismus are tuberculosis, anthrax, symptomatic anthrax, pleura pneumonia, glanders, trichiniasis, actinomycosis and mucous diarrhoea of cattle and swine.

Baccilus coli, bacillus subtilis, bacillus botulinus, paratyphoid bacilli and organisms of the protens group frequently enter foodstuffs. They come from the air, water or hands of those engaged in preparing or marketing foods. These organisms cause alterations in the foods they contaminate, which makes them injurious to the human economy. The longer contaminated food stands in storage or exposed for sale, the

more poisonous it becomes. Certain articles are more prone to injurious bacterial activity than others, among these may be mentioned potted chicken, fish, veal, meat pies, liver and horse flesh.

Cold storage fish, chicken, meat and eggs kept for a long time are dangerous.

The detection of deterioration and changes caused by bacteria usually, can only be made by bacteriological examination. Roughly the age of meat can be estimated by placing a piece of litmus paper against it; immediately after slaughtered meat is alkaline in reaction, later the reaction is acid. Dependent upon the condition under which the meat is prepared or stored its reaction changes from neutral to acid in the course of several hours, days or months.

Boiling and roasting lessens the danger when spoiled foods must be used.

Lathyrismus or lathyrism is a condition of spastic spinal paralysis due to intoxication from eating the seeds of certain species of lathyrus. Sweet Peas are one of the thirteen varieties native to the United States.

Maidismus or Pellagra is a progressive disease characterized by a peculiar form of dermatitis, paralysis and other nervous disorders. It is supposedly caused by eating damaged Indian Corn. Beri Beri is a disease marked by the development of serious multiple neuritis. It occurs among those whose principal or sole article of food is rice, and polished rice is looked upon as the cause of the disease as those who eat unpolished rice apparently escape.

Poisoning sometimes follows the ingestion of canned beans. The clinical picture in such cases is that of gradually developing motor paralysis. Symptoms are first manifest about eighteen hours after eating. There is diplopia or haziness of vision (sometimes ptosis), thickness of speech, difficulty in swallowing, difficult breating, profuse secretion of mucous, and a general failure of muscular power.

Poisoning by milk and its products is called Galactotoxismus. Tyrotoxismus is a condition resembling typhoid fever, caused by tyrotoxicon. It is not due to the extraction of tin,

zinc or other material from containers but is the result of disease in the cow from which it was obtained, or else the presence of colon bacilli.

Tyrotoxismus and galactotoximus may be caused by cheese, ice cream, frozen custard, cream puffs or rice pudding.

Chrome yellow is a poison and when used to color milk or other foods may cause death.

Ptomains are products of decomposition brought about by micro-organisms which break up organic matter into very simple compounds as nitrogen $H_2 S$, CO_2, NH_3 During this process of decomposition ptomains are formed, some are poisonous, the majority are not. All contain N but not all O. ptomains resemble vegetable alkaloids.

CHAPTER VI.

WATER.

Enteric or typhoid fever prevails all over the globe" (Dreschfeld). It is endemic in all large communities and extensive epidemics have been very frequent until recently. Those afflicted are incapacitated for a month or more and 15% of them die.

In 1898 there were 6000 cases of typhoid fever in Philadelphia, each of which represented a loss of $200 to the community. At least 50% of all typhoid fever is the direct result of drinking water polluted with human excreta.

By the proper treatment of sewage and water the occurrence of typhoid fever and other diseases can be largely prevented. Realizing these facts it becomes obvious that the disposal of sewage and purification of water are two of the greatest factors in the elimination of disease.

Water is one of the indispensable requirements of life. As it falls from the sky in the form of rain it is nearly pure. When it reaches the earth and flows into lakes, streams and rivers, or percolates through the ground, it may retain its virgin purity but is very susceptible to contaminations which partly or entirely unfit it for human consumption.

Water is almost a universal solvent and in its passage through or over the earth takes from the ground it touches, various elements, gases and minerals. The amount and nature of chemicals so incorporated is usually so slight and harmless that neither its potability nor wholesomeness are impaired. Sometimes it absorbs free mineral acids, noxious gases, calcium salts, lime, sulphur, iron, copper, arsenic and other poisons which make it injurious or destructive to human life. Water so contaminated often possesses an odor, color or taste indicative of its dangerous properties; sometimes it does not.

The probability of chemical contamination of water is greatly increased by its retention in reservoirs and tanks and

its passage through pipes and hydrants, especially when materials containing lead, arsenic, tin, or copper are used in their construction.

Wholesome, potable water is clear, colorless, odorless and tasteless, it contains minute quantities of mineral substances if any, none of the poisonous metals, very little carbon dioxide, considerable air, few if any bacteria, no pathogenic organisms and little or no organic matter.

Soft water contains the smallest amount of magnesium and calcium salts. Its character is shown by the ease with which it reduces soap to lather. Rain water is the softest. Hard water is that which contains considerable amounts of magnesium or calcium salts and the degree of hardness is in proportion to the quantity of Mg. and Ca. present.

Hardness is of two kinds, Temporary and Permanent. Temporary hardness is due to salts that are precipitated out by boiling. Permanent hardness cannot be changed by boiling.

Water containing more than 1 part in 2000 total dissolved mineral matter or 1 part in 20,000 of the salts that produce permanent hardness should not be drunk nor used in the preparation of foods or beverages.

Water can be deprived of chemical impurities by distillation.

BACTERIA IN WATER.

Nearly all potable water normally contains bacteria. Their number is greatest in lakes, streams and rivers; least in spring water and well water. There are several hundred varieties of bacteria indigenous to water; these are not pathogenic, are harmless to man, and consequently are disregarded.

Under certain circumstances pathogenic organisms get into water. When water so polluted is imbibed it frequently causes serious illness or death.

Water gets contaminated with disease producing organisms by passing over or through ground on which animal and human excreta, especially human, has been deposited. When rain or melting snow so polluted runs off the surface of the earth into springs, open wells, streams or rivers, it carries disease germs with it and dangerously pollutes the bodies of water into which it flows.

When animal or human excreta, especially the latter, is deliberately deposited in springs, lakes and streams, they are polluted and may cause disease if drunk. Likewise, diseased people bathing in water defiles it.

The drainage of sewage into water constitutes the most dangerous kind of pollution.

Beneath the surface of the earth, bacteria can pass laterally through soil for a considerable distance. Consequently cesspools and wells that are not enclosed by impervious walls, and are situated so that sewage from the cesspools flows into the well menace health and sooner or later disseminate disease.

SPRING WATER AND WELL WATER.

Springs and wells in general are less apt to contamination than surface water but they too may be polluted. They should be covered and lined so that no water or anything else can enter them except from the natural source of supply in the case of springs and from the bottom in the case of wells.

Springs and wells are divided in two classes according to their depth, shallow and deep. Shallow wells and springs are those which draw their supply from above the first impervious stratum of the earth. Deep wells and springs are those which draw their supply from beneath the first impervious stratum of the earth.

Water from deep springs and wells is more pure and wholesome than that from shallow wells. Artesian wells are deep wells.

Perversity is so common in man that springs, wells, reservoirs and streams of naturally wholesome water are often unnecessarily polluted, in a manner unsuspected. Hence it is necessary to employ every available means of precluding the pollution of water and to regard that stored in reservoirs and tanks with suspicion.

It is not an uncommon occurrence to find dead dogs, cats and babies in open reservoirs. Sometimes they are even found in covered tanks situated at the top of high buildings. It seems that slow sand filtration immediately before use is the safest procedure, regardless of the source of stored water.

PURIFICATION OF WATER.

Freezing purifies water to a certain extent, but not sufficiently to make that containing pathogenic organisms safe to drink.

Boiling removes temporary hardness and kills all pathogenic organisms.

Filtration through unglazed porcelain filters of the Pasteur, Chamberland and Berkfeld types removes all suspended matter and pathogenic organisms. Slow sand filtration removes dangerous properties almost entirely.

When water from unknown, suspicious or dangerous sources must be used, and filtration is impossible, it should be boiled.

Filtration through tubes of the Pasteur, Chamberland and Berkfeld types can only be done on a small scale; that is, where each building has its individual plant.

Slow sand filtration is the best method for treating large volumes of water, like the supply for a town or city. Slow sand filters are usually covered, but may be constructed without a cover where the temperature does not often fall to the freezing point. They are built with perforated tile floors, which carry the filtered water away. On the tile is a bed of coarse gravel about two feet deep; on top of this is placed a layer of fine gravel of equal depth. Above this is placed a layer of coarse sand several feet deep, and the top layer is of fine bar sand about five feet deep.

It is usually necessary to pass water through a shallow, coarse sand filter, to clear it, before it is run onto a slow sand filter. When a sand filter is first put to work, it removes very few bacteria from the water. After it has been in operation for a short time a gelatinous scum of bacteria forms on its surface. The filter is then said to be "ripe," and the water which subsequently passes through has practically all bacteria removed from it. The gelatinous layer of bacteria on the surface of the filter gradually increases in depth, and, as it does so, the permeability of the filter diminishes. Finally water passes through the filter so slowly that it becomes necessary to scrape away the surface scum and rake

the sand. This is called cleaning the filter, and afterward it must ripen again before it can do its best work.

Occasionally water is treated with chemicals, either for the purpose of removing undesirable mineral substances or to destroy pathogenic bacteria. Lime may be added to water to correct hardness or reduce the number of bacteria.

Alum added to water standing at rest, in the proportion of ½ grain per gallon, will precipitate bacteria and all matter in suspension.

Free chlorine, 1 part to 2,000,000 parts of water, destroys pathogenic bacteria without altering its potability.

EXAMINATION OF WATER.

The quality of water and its fitness or unfitness for use is determined by physical, chemical and bacteriological examinations. Water that has a distinct color or taste imparted to it by matter held in suspension or solution usually is unfit to drink. It may possess excellent therapeutic properties; it may be imbibed for a short time without exerting ill effect, but used continually such water sooner or later injures health.

Any appreciable amount of lead, arsenic, tin, copper, iron or mineral acids in water unfits it for human consumption; so does more than 1 part in 20,000 of calcium, magnesium or sulphur.

Usually when natural water contains an excess of mineral or chemical matter it is generally known, so chemical examination is principally resorted to when epidemics of unknown origin occur which are not traceable to bacteria.

Disorders caused by drinking water are mostly due to pathogenic bacteria in the water, and hence the bacteriological examination of water is the test most frequently employed in determining the fitness of water for human consumption.

Most attempts to discover typhoid bacilli in water are futile, even when the water is causing great epidemics of disease. The same is true of many other pathogenic organisms. We know disease-producing bacteria get into water through its pollution by animal excreta, and that water con-

taining sewage or animal excreta is rich in colon bacilli, containing from 20,000 to millions of colon bacilli per c.c. We also know that pure, unpolluted water contains less than 5,000 bacteria per c.c. and very few or no colon bacilli.

Consequently, the usual procedure is to determine the number of bacteria per c.c. in a sample of water, especially the number of colon bacilli. If the water contains more than 5,000 colonies per c.c., several thousand of which are colon bacilli, that is evidence of dangerous pollution by sewage or animal excreta, and the water is considered unsafe to drink until after boiling or filtration.

CHEMICALS THAT MAY OCCUR IN WATER AND CAUSE DISEASE.

Arsenic	Calcium
Copper	Magnesium
Tin	Sulphur
Lead	Mineral Acids
Iron	

WATER BORN PATHOGENIC ORGANISMS.

Name of Organism	Disease Produced
Bacillus Typhosus	Typhoid Fever
Spirillum of Cholera	Cholera
Bacillus Anthracis	Anthrax (Malignant
Amoeba Hystilitica	Dysentery
Ova of various intestinal parasites	Tape Worms Round Worms Hook Worms
Filaria Sanguinous Hominis	Elephiantiasis (?)
Bilharzia Hematobia	Bilharz Disease (?)
Tubercle Bacillus	Tuberculosis (?)
Paratyphoid Bacilli	Paratyphoid Fever (?)
Bacillus Anthracis (?)	Anthrax (Malignant Pustule) (?)
Bacillus Mallei	Glanders (?)

(?) Question-mark means there is a difference of opinion and no conclusive evidence as to whether or no the disease is transmitted by water.

BEVERAGES.

Beverages are liquids—suspensions, solutions, mixtures or decoctions of various substances in water—or distilled or fermented alcoholic fluids which are drunk by man.

Tea is made from the dried leaves of Theà Sinensis. These leaves as sold are of two varieties, green and black. Both are gathered from the same shrub, the difference in color being due to different methods of preparation. Leaves dried quickly over a fire immediately after they are removed from the plant become green. Those gathered into heaps and exposed to the air for several hours, then rolled by hand and slowly dried over a charcoal fire, become black. Chemically, there is very little difference between green and black tea.

Tea leaves contain 1.35% of theine, 12.36% tannin, 3.62% fat and .67% volatile oil.

Theine, the active principle of tea, is identical with caffeine in effect. When properly prepared and used in moderate amounts tea is a pleasant, harmless, mildly stimulating beverage. When improperly prepared and used excessively, tea is harmful and may cause nervousness, insomnia, hysteria or gastric disturbance.

The proper method of preparing tea to drink is to use one teaspoonful of leaves for each cup of tea. Add the measured amount of leaves to water just below the boiling point and allow them to infuse for not more than three minutes. Then remove the fluid from the leaves and it is ready for use.

The decoction made by boiling tea leaves, and that made by allowing tea leaves to soak in a pot of hot water for hours, is not fit for use. It is harmful.

The adulteration of tea leaves is rarely practiced; occasionally willow or other harmless leaves are mixed with tea leaves. Such deception is easily detected with the naked eye, but if unobserved does not make the beverage injurious.

Coffee is the seed or bean of Coffea Arabica. In the raw state it contains 12% fat, 15% sugar and gum, 1.5% caffeine and 4% caffeine acid. Coffee is roasted in ovens at 400°F. which reduces its weight 25%, and is ground or pulverized.

The infusion of coffee is more pleasing to taste than the decoction but does not contain as much nourishment. Caffeine, the active principle of coffee, is a rapidly acting stimulant to the brain and spinal cord; it increases pulse-rate, blood-pressure and the excretion of urine. It is a conservator of body tissue and is a valuable aid in the treatment of opium poisoning. (Hare).

Coffee is a food as well as a beverage, especially if the dregs or grounds are drunk and assists one to withstand fatigue, cold and exposure. Coffee is more liable to cause insomnia than tea and frequently disturbs the gastro-intertinal functions.

Innumberable substances are used to adulterate coffee, among these are chicory, beans, peas, wheat, flour and corn-starch. Powdered coffee has a characteristic appearance under the microscope and the presence of any adulterant can easily be determined by microscopic examination.

Coffee contains no starch; most of its adulterants do; hence when a solution of a suspected sample is treated with iodine no reaction occurs if it is pure coffee. If adulterated with starch containing vegetables the solution turns to a dirty blue color.

Substitutes for coffee are chiefly composed of roasted and ground peas, beans, wheat, etc., mixed with more or less coffee.

Cocoa is derived from the seeds or beans of the Theobroma Cacao tree. The seeds when removed from the tree are permitted to ferment in the open air for a short time. They are then shelled, roasted and ground. Cocoa contains 49% fat, 13% starch, 13% proteids and a small amount of theobromine, which is an alkaloid weakly similar to caffeine.

Cocoa makes a beverage which is rich in food value, very slightly stimulating and agreeable to taste. It rarely disturbs even the most delicate stomachs.

Chocolate is a mixture of cocoa and sugar.

The various substances that have been used to adulterate cocoa and chocolate do not detract from or lessen the food

value of the product and are not injurious to the human economy—hence do not merit our attention.

ALCOHOLIC BEVERAGES.

Beer is an infusion of malted barley flavored with hops and fermented with yeast.

Porter is a beer with a high percent of alcohol and made from malt dried at a high temperature.

Stout contains less alcohol and hops but more malt extract.

Ale is a pale beer containing more hop extract and less malt extract than porter or stout and is brewed by top fermentation.

PREPARATION OF BEER.

Barley is steeped in water for several days, removed from the water, arranged in heaps which are turned repeatedly until germination has progressed to the required extent, then dried at a temperature of about 90°F. and finally heated at a temperature between 125° and 180°F.; the degree of heat being determined by the color and flavor of the finished product desired. The barley is then screened to separate it from its germs and rootlets and the resultant malt is crushed and an infusion, called "wort" is made of it putting it in water at 160°F.

Hops are added to the wort and it is boiled for an hour or two; then it is rapidly cooled and yeast is added. Fermentation is allowed to progress for several days, until most but not all of the sugar is reduced. The beer is then separated from the yeast, clarified, by passage through vats containing chips of beechwood, hazel, flax seeds, carrageen, glatin or other clarifying agents.

It is then stored in casks and slow fermentation at low temperature progresses for a time, after which it is ready for use.

A number of different grains, including rice and corn, may be added to or substituted for barley in the preparation of beer without altering its effect as a beverage.

It is stated that substitutes for hops are rarely employed by brewers but a great number of bitter substances may be used. Most of these are harmless; some are poisonous; among the latter may be mentioned strychnine.

The reports of investigations made by various health boards indicates that there is practically no danger at the present in the United States from substitutes for barley and hops in beer.

Glucose is sometimes added to beer, and if pure is harmless. But if in its manufacture the glucose is contaminated by arsenic, as may occur, its addition to beer constitutes a dangerous adulteration. Beer containing such glucose has poisoned many people and caused death.

The addition of preservatives to beer, which is a common practice, is distinctly detrimental to health. Salicylic acid, sodium fluoride, sodium bicarbonate and sodium chloride are the substances most frequently used. Their use should be prohibited. This applies equally to wines.

Considering the light and dark beers together—Lager, ale, porter and stout—their average alcoholic content is between 4% and 5%, and their extractives 5% to 7%.

WINE.

Wine is the fermented juice expressed from grapes. Beverages prepared from the juices of other fruits, as gooseberry, are also called wine.

Those containing little or no sugar are called dry wines. Sweet wines contain from 4 to 20% sugar. Natural grape juice after fermentation contains less than 1% of sugar and that in excess of this amount is added to wine after its removal from the vat.

When grapes are crushed and fermented together with their skins the resultant wine is red. If the skins are removed from the grapes before they are fermented the product is white wine.

Natural wines contain only the alcohol produced by their fermentation; fortified wines have alcohol added to them.

Sparkling wines are those to which sufficient sugar is added, after bottling to charge them with carbonic acid by fermentation.

The following table shows the alcohol and sugar content of some of the commonly used wines:

RED WINES.			WHITE WINES.		
Name	Alcohol	Sugar	Name	Alcohol	Sugar
Claret	10-12%	1-10%	Ch'mpagne	10-12%	1-4%
Burgundie .	10-12%	1-10%	Rhine	10-12%	" "
Sherry	15-20%	5-15%	Moselle ...	10-12%	1-4%
Port	15-20%	10-15%	Tokay	10-15%	5-10%
Madeira ...	15-20%	5-15%			

Innumerable fruits and berries, including raisins, apples, prunes and beets, are substituted for grapes in the manufacture of wine and its counterfeits. These are practically harmless.

What was said in regard to the addition of preservatives to beer is especially true concerning wine.

SPIRITS OR DISTILLED ALCOHOLICS.

Whiskey is the distillate of fermented barley, rye, oats, wheat, corn or potatoes. It contains from 40% to 60% of alcohol and fusel oil. The amount of fusel oil depends upon the age of the whiskey; as it ages the fusel oil diminishes. Fusel oil produces nausea and gastric disturbances.

Brandy is the distillate of wines, or of the refuse left after pressing fruit, or of the dregs of wine casks, or of a mixture of all three, mare wine and less. It contains about the same amount of alcohol as whiskey.

Rum is the distillate of fermented molasses. Gin is made by adding hops, juniper berries, cassia buds, orange peel, cardamon or other vegetables to rye or barley spirits. Rum and gin both contain about 40-50% alcohol.

Counterfeit whiskey, brandy and gin are made by adding to water alcohol, potato spirit, wood alcohol and ether, or other obnoxious fluids, flavoring them with all sorts of decoctions, infusions and essences and coloring them with harmless vegetable juices or harmful chemical dyes. Frequently the crime is completed by the addition of poisonous coal tar products.

Liqueurs and cordials are prepared in much the same way; most of them, especially absinthe, have a similar bad effect on the human body.

Are alcoholic beverages foods or poisons; are they indispensable therapeutic agents or not; is their use justifiable or not?

These are mooted questions and will continue to be.

The preponderance of evidence indicates that they are not foods. The use of alcoholic beverages by immature persons is always detrimental and constitutes a grave insidious danger.

Mature healthy persons are not appreciably benefited by their use; frequently they are injured or destroyed by it.

In a limited number of cases alcohol may be an excellent therapeutic agent; probably there are other less dangerous agents equally efficacious. Certain it is that alcoholic beverages, directly and indirectly, have caused more pain and misery than they have assuaged, have produced more disease than they have modified, cured or aborted, and have destroyed more lives than they have saved.

CHAPTER VII.

GARBAGE DISPOSAL, PLUMBING AND SEWAGE DISPOSAL.

GARBAGE.

Garbage is literally defined as animal and vegetable refuse from kitchens; ordinarily the term is applied to a greater variety of domestic refuse.

The average composition of garbage is 60% moisture, 20% dry animal and vegetable matter, and 2% to 4% grease. Such a substance exposed to light and air ferments and decomposes, giving off disagreeable odors. It attracts flies, mosquitoes and rodents, and forms a favorable breeding place for flies. For these reasons, garbage permitted to remain in or near dwellings in leaky or open containers is a menace to health. Garbage should be deposited in water-tight covered cans, and these cans should be emptied daily and their contents disposed of daily.

GARBAGE DISPOSAL.

The amount of garbage per capita of population that accumulates in a community each day depends upon many factors. In general, it increases in proportion to the wealth, and ignorance of a community; in any case, it is large.

Most American garbage has a high food-value, and the ideal method from an economic view of disposing of it would be to remove it daily and feed it to swine. Garbage should be transported in water-tight covered vehicles, and such wagons or cars should never be used to transport milk or other substances intended for human consumption. Garbage is a good soil fertilizer, and when applied properly enriches the land without creating a nuisance or endangering health. Garbage reduction is a method of disposal applicable to the refuse from communities of 100,000 population or more. It is the extraction by one method or another of the ingredients having a commercial value, after which the remainder is incinerated.

More than 75% of the bulk of garbage has some commercial value, the most important being fat. Tankage is a particular form of reduction by which the garbage, placed in tanks, is deprived of water and moisture, the water being disposed of as sewage. When dry, the garbage is mixed with naphtha, which extracts the fat, after which the residue is again dried and sold as fertilizer.

Incineration, as the name implies, is the destruction of garbage by fire. This method of disposal is adaptable to any amount of garbage. The heat generated may be utilized to generate steam, electricity or other power, and, in many instances, incineration creates no nuisance where reduction would.

HOUSE DRAINAGE AND PLUMBING.

The labor incident to bathing, preparing food and washing the interior and contents of dwellings is lessened by the installation of fixtures supplying water. For the further convenience and comfort of tenants, dwellings are equipped with sinks, tubs, basins, water-closets and drains, arranged to receive and carry away dirty, polluted water, feces, urine and other excrement. These things enhance health when properly constructed and operated. Improperly operated or constructed they endanger health and may become a source of disease. Proper plumbing is a boon to life; defective plumbing may be worse than none. Excepting food and service, there is nothing in a house so intimately related to the health of dwellers as its plumbing, and plumbing is as susceptible to fraud and injury as medicine itself; consequently, it is essential for those engaged in the extermination of disease to know what good plumbing is and how to detect faults in so far as these matters are related to health. The first perquisite of good plumbing and house drainage is an adequate supply of water to flush the pipes. All joints must be airtight, and every fixture, water-closet, urinal, sink and bathtub must be trapped. Faulty joints and traps permit sewer gas to escape into the house. A trap is an arrangement which causes a portion of a pipe to be constantly full of water, the water forming an impervious obstacle to the passage of gas. Traps are so constructed that objects unsuited

to passage through pipes, and hence apt to obstruct them, usually lodge in the trap, the construction of which makes the removal of foreign matter easy.

Traps are interposed between fixtures, such as water-closets, sinks or tubs and waste pipes.

Waste pipes are those which carry the dirty water and excrement from water-closets, etc., to the soil pipes. They are usually constructed of iron or lead, and should be erected so as to offer the least possible resistance to the passage of water; that is, they should be free of sharp angles and curves and given as much fall as possible; never laid perfectly horizontal.

Every fixture should have its own separate waste pipe. Soil pipes are large, vertical pipes extending from the main drain to two feet above the roof. The top should be open and uncovered, to ensure ventilation and prevent syphonage of traps. Only heavy iron pipes should be used as soil pipes, as lead pipes are apt to sag, and are easily perforated by nails and otherwise more liable to injury than iron. Soil pipes commonly have bell joints, and these should be caulked with oakum and molten lead. Like all other drainage pipes, soil pipes should be free of sharp bends, and should not open in the drain at right angles, but curve into it.

In a small house, one or two soil pipes are sufficient to collect the discharge from all the waste pipes. Larger buildings require more.

The drain or drain pipe is the largest pipe in the house, and extends along the cellar wall toward the front of the house in a horizontal direction, but with as much incline as possible, never less than ¼-inch fall to the foot. Drain pipes should be entirely exposed, made of heavy iron exclusively and have caulked, air-tight joints. Just interior to where the drain passes out of the house through the wall it is trapped.

This main trap is constructed so that it can be opened and cleaned. On the house side of the main trap a fresh air inlet opens into the main drain. The fresh air inlet extends from the curb, where it is covered by a perforated iron box.

Heavy iron piping must be used for the continuance of the drain outside of the house until it reaches a point ten feet from the house wall, beyond which point terra cotta pipe may be used.

Inside water-closets have been constructed in various ways—pan-closets, off-set hopper closets and wash-out closets are less desirable than syphon jet closets, because they have a greater fouling space and are harder to clean.

A syphon jet closet is simply a modified S-trap, the receiving portion of which is funnel shaped. This is flushed by two streams of water. One follows in around the top of the bowl, and the other shoots from the lowest toward the highest portion of the trap, exerting and ejecting force on the contents and at the same time creating a syphonage, which assists emptying the closet.

Indoor water-closets should be constructed of vitreous china only. In climates where freezing does not occur, out-door water-closets should be exactly the same as in-door closets; that is, they should be of vitreous china, syphon-jet closets.

Where freezing does occur, exposed water-closets must have the traps beneath the freezing line, which in this country is 3½ feet beneath the surface of the ground; in such closets there is always a fouling space of 4 feet or more. For this reason these closets are undesirable. Since they cannot be kept clean, there is no reason to make them of china, and iron, which is less expensive, is commonly used.

These closets should be flushed by an apparatus controlled by an automatic anti-freezing valve, which causes the tank to fill while the closet is being used and flushes it immediately afterwards. Every water-closet seat should be fitted with a cover that will prevent flies from entering the bowl, and this cover should never be raised except during the time the closet is in use. This applies especially to out-of-door closets. Wash basins, sinks and tubs of all kinds should be made of hard material that is impervious to water and not easily cut, cracked nor dented. They should have smooth surfaces that facilitate complete drainage. Surfaces upon which foreign matter becomes conspicuous, and they should be easy to clean and keep clean.

There should be the shortest possible distance between their outlets and traps.

All should be cleaned and dried immediately after use. Aside from appearance, it is highly desirable that the plumbing of dwellings be exposed to view, what is termed "open plumbing," because leaks can then be more readily detected and easier located. When a leak in the waste or drain pipes is suspected or known to exist, there are various methods of proving its presence and locating it, such as pouring essence of peppermint into the vent-pipe from the roof, the odor of which will be striking at the point of leakage.

SEWAGE.

For the purpose of this study we will define sewage as the excreta of man, the waste products of slaughter houses and factories, and all other household and industrial refuse which under natural conditions would, in whole or part, be deposited on the soil or washed into streams of water and there become a menace to health.

When rain falls on ground polluted by sewage or upon impervious city streets that are strewn with animal excreta it becomes sewage.

The sewage of different communities varies greatly as regards composition and quantity per unit of population.

The average composition per one thousand parts according to Rosenberger is; water 998, urine 1, organic matter 1.

The most offensive and dangerous portion of sewage is human excretion, particularly feces. Even in sparcely settled districts, where families are separated by acres of territory, people should not deficate promiscuously upon the land or into streams. In thickly settled rural districts, in villages, towns and cities, the health of people depends upon the proper treatment and disposal of sewage.

The object to be attained in all cases is the same. Sewage must be treated in a manner which will reduce to a minimum its content of pathogenic bacteria and the offensive and poisonous products of decomposition. The smaller the amount of sewage, the more simple is the problem.

No one of the known methods of sewage disposal is applicable in all cases. The size, geographical situation, industries and wealth of a community are factors in determining the proper method of sewage disposal.

Sewage can be partly or entirely deprived of its noxious properties by combustion, heating to dryness, aeration (oxidation), bacterial decomposition or chemical treatment.

Burning sewage or heating it to dryness and using the resultant powder for fertilizer is rarely practiced in America and will probably continue to be unfavorably considered for a long time. The chemical treatment of large amounts of sewage is often impossible and is usually inferior to other methods.

Aeration, oxidation and bacterial decomposition are nature's ways of disposing of sewage and most of the plants devised and constructed for sewage disposal are simply provisions to isolate, hold and control sewage while bacterial decomposition and oxidation progress to more or less complete reduction.

Where there is no proper public system of sewers and sewage disposal, and each house must dispose of its own waste, the best method of disposing of urine and feces is that devised by Lumsden, Roberts and Stiles.

It consists of two ordinary water-tight barrels. One receives the excreta and acts as a septic tank. In it solids are liquified. The other acts as an effluent tank. In it the effluent undergoes bacterial purification or may be treated chemically. Kitchen and bath water should be drained into a similar apparatus, and the effluent might safely be permitted to percolate away through the ground.

The deposit of feces in covered boxes containing dry earth, charcoal or lime, and burying the contents of these boxes when full, does away with the bad odors and considerably reduces the dangers that may be associated with the feces and urine, but is not as safe, as easy, nor as inexpensive as the method of Stiles in most cases.

In regard to houses equipped with drainage pipes and discharging their refuse matter into a sewage disposal plant

of their own, opinion differs as to whether it is better to drain and treat urine and feces separately or to use a common drain for urine, feces, kitchen waste, bath water and drain water. We believe the separate or double system best and realize that each case must be decided on its own merits.

When we consider towns and cities where the houses are drained into public sewers, the question again arises. Should there be two separate systems of drains, sewers and sewage disposal, one for household waste and another for rain water, or a single common system for both? Here another question arises, should industrial plants be permitted to discharge their raw waste products into sewers or should they be compelled to first remove from it substances that are injurious to sewer pipes and sewage disposal apparatus and interfere with the reduction of other substances?

In many cases a single sewage system and a single disposal plant will protect the health of a community quite as well as a separate system; in other cases the best protection of public health cannot be provided by a single system but requires a double system. Likewise, the waste products of some industries do not endanger public health when discharged into public sewers; others do. Since the protection of health is of paramount importance, that method of drainage and sewage disposal which will best protect it should be established in every case.

THE SEPTIC TANK.

Mr. Donald Cameron, of England, devised a method of sewage disposal which is known as the Cameron or Septic Tank method. The sewer pipe empties into a detrius or settling chamber where large bodies, such as sticks and tin cans, are caught by a screen, and stone, gravel and sand fall to the bottom. From the detrius chamber the sewage is discharged into a tank, the septic tank, through which it passes very slowly and in which the solid organic matter is dissolved by the action of anaerobic bacteria. The effluent from this tank which is a yellowish, offensive smelling fluid leaves the tank through an opening opposite the point of

entry, and at the same level, namely, midway between the bottom of the tank and the service. This exit extends the entire width of the tank and as the effluent passes out of it, it falls in a broad thin sheet into a collecting chamber, or as it is sometimes called, a dosing tank. The effluent leaves the septic tank in a thin sheet so that the air will come in contact with it. When the collecting chamber or dosing tank becomes full it discharges the effluent on to a filter bed where it is further purified by oxidation and the action of aerobic bacteria. The water which comes through this filter bed is colorless, odorless and non-putrescible provided the tank and filter are of proper construction and correctly worked. Some essentials in the successful operation of a septic tank are:

First, that the inflow does not disturb the scum formed on the surface nor cause eddies or currents; second, the depth of the septic tank should not be less than 5 feet nor more than 12 feet; third, the rate of flow through the tank should be not less than ½ inch per minute nor more than 1 inch per minute, and the time required for matter to pass from entrance to exit should be 24 hours; fourth, the surface scum should not be disturbed; fifth, the collecting chamber or dosing tank should be of sufficient size to hold 6 hours' overflow or effluent from the septic tank.

The conditions necessary for the proper operation of sewage filter beds of all kinds, except those fed by sprinklers are that they be of sufficient size and number, so that the amount of septic tank effluent placed on them at one time is not more than 3 inches and that an interval of 6 or 8 hours is permitted between doses. Raw sewage should not be run on filters more than once or twice in 24 hours, nor to a greater depth than 2 inches. One week out of every five, filter beds should be given a rest. They should be underdrained so as to promptly and completely get rid of water after percolating through the filter bed.

Cameron's original septic tank had an air-tight cover; later it was discovered that this was unnecessary as the scum which forms on the surface fulfills the same purpose. Today septic tanks are constructed with and without covers. The degree of sewage reduction that takes places in a septic tank

depends upon the composition of the sewage and the condition under which the tank is operated. Sewage composed of human excreta and household waste only is the easiest to purify; that which contains industrial refuse is the hardest. Septic changes are greater when the temperature is above 70°F. than when it is below. Under favorable conditions all the sludge will be liquified in the septic tank, this was the case at Lawrence, Mass., for a number of years. Ordinarily from 75% to 90% of the sludge is reduced or retained in the tank.

Sewage is made less offensive and dangerous by passage through a septic tank but the effluent from a septic tank is not proper nor safe matter to enter streams used for drinking water.

The putrefaction that occurs in a septic tank is the work of anaerobic bacteria, consequently reduction of sewage in a new tank is slight until the air-tight scum forms on the surface and excludes oxygen. When the effluent is ready to leave the septic tank it is practically airless and free from oxygen, hence the necessity of complete aeration. Most of the sewage that cannot be reduced by anaerobic bacteria can be decomposed by oxidation and aerobic bacteria. That is the reason the effluent from septic tanks is aerated and passed on to filter beds.

FILTRATION OF SEWAGE.

Sewage filters are not designed to act as mechanical screens, to hold back everything but water. They are intended to be beds permeated throughout with air and aerobic bacteria which oxidize and decompose sewage as it slowly trickles through. Were it not so, after a little use sewage filters would be buried deep beneath a load of solid filth.

As it is, filters properly constructed and operated for years rarely need cleaning and contain little or no muck.

The efficiency of sewage filters depends upon the amount of sewage placed upon them. No more sewage should be consigned to a filter at one time than the amount of air and bacteria in the bed can decompose, and after the filtrate has passed from the bed the filter must remain at rest a sufficient time for air to penetrate every part of the bed.

Sewage filters of all shapes, sizes and composition have been constructed and are in use. Some are lined with clay, others with brick, stone or concrete; it makes little difference which. Some are underdrained by terra cotta pipes, others by split tiles and some by brick conduits and these drains are laid in various ways. The important feature of any drain is that it completely and rapidly removes the filtrate under all conditions and that it carries air to the bottom of the filter bed. The depth of a filter bed should never be less than three feet; every additional inch adds to the efficiency of the filter and five feet is generally regarded as the best depth. Filter beds have been made of charcoal, coal, limestone chips, slag, gravel, graduated sizes of broken stone and sand. Under similar conditions they work equally well. Every man who has mixed together a new combination of filter bed materials has given his name to the process. It would be impossible and undesirable to mention them all.

To some extent the rate of flow through a filter and the degree of purification depends upon the size of the material of which the bed is composed. Three-inch crushed stone, slag or cinders is the coarsest material used, a layer of such, one or two feet deep should be placed around the drains and form the bottom of the bed in every case; on top of this is placed a layer of one inch crushed stone, coke, coal or gravel several feet in depth and the top layer, which is from 1 to 5 feet deep, is usually sand, sometimes chipped limestone. Five feet of fine sand is most efficacious.

All filters upon which sewage is flooded at intervals are called Intermittent filters. The treatment of sewage by this method is known as Intermittent filtration. Usually sewage is passed through a septic tank before filtration. When this is not the case, where crude sewage is directly deposited on an intermittent filter, the filtrate should be passed through a second filter bed.

SPRINKLING FILTERS.

Sprinkling filters differ from Intermittent filters in that the raw sewage or septic tank effluent is delivered to the surface of the bed by sprinklers. The passage of the sewage through the air in the form of a spray from the sprinkling

pipes, favors considerable oxidation before the material reaches the bed and hence hastens its reduction and relieves the beds of a portion of their work. For this reason properly fed sprinkling filters can be operated almost continuously and the beds seldom require rest for aeration. Sprinkling filters are well adapted to the treatment of effluent from septic tanks but their employment for the treatment of raw sewage under most conditions will not effect the required purification.

Usually the beds of sprinkling filters are made of coarser material than is used in the construction of Intermittent filters.

Whittaker and Bryant, who introduced the sprinkling filter, built their first bed with a title floor and a 9-inch main drain; above this was 2 feet of 3-inch broken stone, 6 feet of 1-inch coak and 1 foot of limestone chippings. They passed the sewage through a septic tank and then fed the effluent continuously to the sprinkling filter.

The Scott Moncrieff System is a combination of open septic tanks and multiple shallow filters so arranged that the effluent from one drops in the form of rain through several inches of air before reaching the next bed.

CONTACT BEDS.

Contact beds are constructed the same as filters except that the drainage system must be so constructed as to permit the retention of filtrate at will, and the material of which the bed is composed is much coarser than is used in filters. They are operated by closing the drain, flooding the surface, permitting the sewage to remain in the bed for a number of hours, then opening the drain for the escape of filtrate and permitting the bed to rest before another application of sewage. Contact beds are inferior to filters.

IRRIGATION.

Sewage may be carried to farms where it is used to irrigate and fertilize the land. Under some circumstances, as has been proved, this is a safe and profitable method of disposal; probably the best. However, there are conditions under which

this method is improper, as, for instance, in a community where hook-worm infestation prevails and the available ground is composed of clay.

Raw sewage discharged into the sea does not endanger health provided it is emptied where neither tide nor current will deposit it on the shore or upon oyster or clam beds.

Under ordinary circumstances the chemical treatment of raw sewage is inferior to the methods described. It is expensive, and to be successful requires constant skillful attention. Lime, iron sulphate and alum are most frequently used.

Lime is used in the proportion of 1 ton to a million gallons of sewage. Pure lime should be made into a milk by mixing with water and then added to the sewage. The effect depends upon the degree of uniformity with which it is mixed with both water and sewage.

The Amines Process is the same as above except that one part of herring brine is added to 10 parts of lime.

Sellars' A B C Process is the treatment of sewage with a mixture of alum, charcoal and clay.

The Hermite Process and Webster's System are both methods of sewage reduction and sterilization by Electrolysis. They are both inapplicable in most cases.

The Liernur System, and its modification, the Berliner System, are methods of rapidly drawing night soil through drain pipes and sewers by vacuum suction. They have been little employed and are seldom recommended.

CHAPTER VIII.

ATMOSPHERE AND SOIL.

Humidity.—The amount of aqueous vapor in the air is determined by means of hygrometers. They are direct, as Daniell's, Davis & Regnault's which determine the dew-point of the atmosphere, or indirect as the wet and dry bulb thermometer, the psychrometer and the hair hygrometer.

The main points to be determined by hygrometry are the dew-point, vapor tension, or absolute humidity and the relative humidity of the atmosphere. The dew-point is that temperature at which the air is saturated with moisture, so that the least fall in temperature causes a deposit in the form of dew. The higher the temperature of the air, the larger the amount of water vapor it can hold; if the temperature be lowered, the amount of moisture remaining the same, eventually a point is reached at which some of the moisture is precipitated; this temperature is indicated directly by the condensitor-hygrometers or can be calculated from the readings of the psychrometer.

The Elastic Force of Vapor is the amount of barometric pressure due to water vapor present in the air.

The tension of aqueous vapor at 100°C. is 760 m.m. of mercury; that is the pressure of one atmosphere. At lower temperature the elastic force is less. The elastic force of vapor is greatest within the tropics and diminishes toward the poles; it is greatest over the ocean and diminishes as we go inland. It is greater in summer than in winter; greater at mid-day than in the morning and generally diminishes with increased elevation.

Absolute Humidity is the weight of H_2O in the form of vapor contained in a given volume of air, expressed in grams per cubic meter. It varies with the temperature and may be computed from wet and dry thermometer readings.

Relative Humidity.—Complete saturation of the air being taken as 100, any degree of dryness may be expressed in percentage.

The amount of aqueous vapor actually present and the amount that would be present if the air was saturated, being known, the former is expressed as a per cent. of the latter, giving the relative humidity. Thus a relative humidity of 80 means, that at the observed temperature the air contains but 80% of the amount of vapor it could take up.

Aqueous vapor is a normal constituent of the air in variable amounts, influenced by a number of natural conditions, chiefly temperature. It is an invisible gas, lighter than air, very unequally diffused. The sources of aqueous vapor are numerous; some comes from the evaporation of water; some from the soil, some from the lungs and skin of man and animals, some from the leaves of growing plants and some from combustion.

The evaporation of water from foliage tends to keep the temperature below the point where vital processes would be interfered with.

Air that is not saturated with vapor, that is, air having a relative humidity of less than 100, can absorb moisture from any source; when saturated, the air can take up no more moisture but plants and animals can continue to give off moisture which at once condenses and precipitates, perhaps on the very surface where it originated: the leaf of a tree or the skin of man. Under such circumstances sweat cannot evaporate. That is why high temperatures are more intolerable on damp days, when the air is saturated, than on equally hot days when it is not. While saturation of the atmosphere increases discomfort in the summer by preventing the cooling effect of evaporation, it also causes discomfort in winter by extracting heat from the body—cold moisture absorbs large quantities of heat.

We are familiar with the suffering caused by a damp, sticky day in summer, a day when the air is both hot and saturated with moisture; some are familiar with the accentuation of cold when the humidity is high. It is said that in East

Siberia the air is very dry and that persons living there, by keeping free of moisture can survive in a temperature of —50° to —60° F., while if their clothing become moist the cold would soon kill them.

A very low humidity may produce discomforts by permitting marked sudden changes in temperature.

Aqueous vapor exerts a highly important influence.

By day it absorbs part of the sun's heat and tempers it; by night it acts as a protecting blanket to the earth, preventing too great a loss of heat by radiation. At night the earth gives up part of the heat absorbed during the day and when the air is very dry and the sky very clear, the temperature falls much more than when more moisture is present to prevent evaporation.

At high altitudes and in great deserts, the aqueous vapor blanket may be so thin that fall in temperature at night is very marked, permitting ice to form where a few hours before it was hot.

The mean relative humidity varies in different countries and where artificial ventilation and heating is required, the atmosphere of buildings should be maintained at the mean relative humidity of the locality in which the building is situated.

Of more importance than the amount of vapor in air is its source; vapor from ground water is generally considered harmful.

SOIL.

Rock, sand, clay and gravel are included in the consideration of soils. Soils vary in physical and chemical constitution; they may consist exclusively of sand, clay or disintegrated calcareous matter, or a mixture of these together with vegetable matter undergoing slow oxidation. In forests a layer of slowly decomposing vegetable matter of varying thickness is found covering the earth; this organic stratum is called humus and when turned under by plow or spade and mixed with sand or clay, it becomes ordinary agricultural soil.

The interstices of soil are occupied by air or water or both; the amount of air being dependent upon the porosity of

the soil; gravel, sand and loose soil may contain from 30 to 50% of air by volume, porous sandstone almost 30%, clay much less and dense stones, such as marble and granite, contain comparatively little air.

The atmospheric air that passes into the soil is called ground air. It takes part in the various chemical decompositions going on there; as a result, the relative proportions and numbers of its constituents are altered; oxygen is decreased, CO_2 is increased and various putrefactive products may be taken up.

In ordinary agricultural soil it has been found that the oxygen diminished to half the proportion normally present in atmospheric air, while the CO_2 was enormously increased. This excess of CO_2 is the product of oxidation of carbonaceous matter which takes place in the soil.

Ground air is rich in bacteria, chiefly moulds and putrifactive organisms, but occasionally pathogenic bacteria are present; among these are the B. anthrax, B. malignant edema, B. tetanus, and B. typhosus.

Owing to differences of temperature and pressure ground air frequently permeates houses, entering from cellars or basements. This is most apt to occur in winter, when the difference in temperature between indoor and outside air is greatest. Heavy rains may force ground air through the soil, especially if the soil is porous. The entrance of ground air is prevented by cementing cellar floors, ventilating basements and raising the main floor above the level of the ground. In spring and early summer ground air is cooler, denser and heavier than that above and is not easily displaced, this may be a factor in the lessening of the infectious diseases in these seasons.

The proportion of CO_2 is greatest in ground air during July and least in March. The air at a depth of 4 meters below the surface of the earth contains only 7 to 10% of oxygen.

The water of soil or ground water.—At a variable depth below ground a stratum of earth or rock is found through which water passes with difficulty if at all; above this impervious stratum there is a variable amount of water, called

ground water. It varies in depth at different times owing to the amount of precipitation (rain or snow).

Ground water tends to flow from higher to lower levels and passes toward the drainage area of the district, usually toward lakes, rivers or the sea. Rain or a rise in the river causes a rise in the ground water; dry weather causes a fall.

The greatest portion of our drinking supply is drawn from ground water, hence the protection and purification of it is essential to health.

Cesspools and manure heaps of necessity contaminate the soil and ground water for a distance below and around them; water so contaminated is unfit for drinking and other domestic purposes. Wells should not be placed too near privies or other sources of pollution.

It should be remembered that water may flow from a well in low ground to one in higher ground.

If pathogenic bacteria get in soil they may multiply and gain access to wells and streams infecting the water.

It is said that a locality with a persistently low stage of ground water, 5 meters from the surface, is healthy and that a persistently high stage, 1.5 meters or less below the surface, is unhealthy; worst of all is a fluctuating level of ground water.

This is the case in India; the rainy season continues from May to October and during the next 6 months very little rain falls; cholera is endemic and its death rate in Calcutta bears a distinct relation to the movements of the ground water. Deaths steadily increase from October to May and decrease from May to October.

Typhoid fever also has a definite relation to the rise and fall of ground water; to a less extent, so does dysentery, uncinariasis, anthrax, swine plague, hog cholera and tuberculosis.

Kober (Amer. Jour. of Med. Sci. Nov. 1909) explains the relationship of dampness to tuberculosis as follows: "Dampness of soil, unless special precautions have been taken, extends by capillary attraction to the walls and renders the entire house damp Damp air abstracts an undue amount of

animal heat, lowers the resistance of the inmates and predisposes to catarrhal affections, and these in turn render the mucous membranes more vulnerable to the invasion of the tubercle bacillus.

There is also reason for believing that the tubercle bacillus retains its vitality for a greater length of time in such an atmosphere on account of its humidity and excess of organic matter."

Soil drainage contemplates the removal of ground water or reduction of its level. It may be accomplished by planting certain trees.

Eucalyptus trees, planted in sufficient numbers will produce dry soil on marshy land.

Sewers should never be used to drain soil. Where pipes are employed for the purpose they should be porous, freely capable of admitting water from without, protected from occlusion and laid at a depth of from 3 to 5 meters below the surface of the earth.

Ordinary agricultural drain tile meets the requirements. Coarse gravel or broken stones may be used to drain soil, and it can be accomplished by ditches to a certain degree.

Stiles, in reference to soil pollution, stated that he examined 20,000 closets and found that soil pollution occurred all around, spread by chickens and hogs. Sixty-eight per cent. of the farmhouses in North Carolina, South Carolina and Alabama had no toilet of any kind whatsoever. Similar conditions prevail throughout the rural districts of the United States.

The institution of sanitary toilets would cut the typhoid death-rate in two and almost eradicate hookworm disease, amebic diarrhea, dysentery, cochin-china diarrhea, tape worm and eel worm disease.

The vast distribution of hook-worm disease in the South is a natural result of the large negro population, character of the soil and climate and the unsanitary habits of the majority.

Nearly all animals harbor parasites in their intestinal canal. Eggs are passed in their droppings and develop into

young worms, which reinfect the live stock. If in constant use, ground becomes heavily infested with young worms and germs. A warm, moist season especially favors the development of these parasites, and during such a season infection of stock is most severe. Horses, cattle, sheep, swine and chickens are protected from these dangers by frequently moving them from one pasture to another, that is, from infected or polluted soil to soil which is not polluted.

Human beings are vulnerable to the same or similar affections, and to avoid them must be protected, as are the lower animals; that is, they must be afforded unpolluted soil on which to live.

Since people cannot frequently change their location, to preclude infestation, the soil on which they live must be protected against pollution by man or beast.

CHAPTER IX.

VENTILATION AND HEATING.

Observation of similar groups of men, some living in a vitiated atmosphere and others in a pure atmosphere, has shown that impure air is injurious to health. Such observations have been confirmed by experiments.

Open air, which we generally consider pure, is composed of Oxygen, 1 part; Nitrogen, 4 parts, and contains about 2 parts per 10,000 of CO_2, a variable amount of moisture and less important substances.

Animal life requires the inhalation of oxygen and the exhalation of CO_2, so that in breathing we not only rob the air of a room of oxygen, but also increases its CO_2. It is an excess of CO_2 rather than paucity of oxygen that makes vitiated air harmful. When the CO_2 content of the air rises to 6 parts per 10,000, it is deleterious to health. Thirty parts per 10,000 causes headache and vertigo.

To preclude the danger of re-breathing the air, there must be a constant supply of fresh air equal to the amount breathed, which is between 30 and 50 cubic feet per minute for an adult. The replacement of vitiated air by pure air is called ventilation.

The density and weight of air becomes less and its volume and power of diffusion increase as its temperature rises. Consequently, there is always a tendency for the heated air of a room to escape and for the cooler outside air to enter. Even buildings constructed with the intention of making them air-tight are pervious to air, the amount that penetrates them being dependent upon and in proportion to the difference between inside and outside temperature and the prevalence of winds. Methods of ventilation are restricted by several well-known facts: 1st, chilling of the body is harmful; 2nd, perceptible draughts are frequently injurious; 3rd, marked fluctuations in room temperature are dangerous.

To preclude these dangers it is usually necessary to so regulate the admission of fresh air and extraction of foul air as to prevent it from blowing on those in a room and to prevent the creation of strong draughts. Air traveling less than 3 feet per second at a temperature of 60° F., or less than 4 feet per second at 70° F., is imperceptible; stronger draughts are dangerous, especially if the air is cool. This limits the size of and placement of air intakes and outlets, the velocity of air currents and the minimum size of rooms. To prevent chilling and fluctuations of temperature, it is usually necessary to warm fresh air before it enters a room.

The natural forces of ventilation, winds and diffusion, acting through frequently opened doors, through cracks and loose windows, ventilate private dwellings more or less efficiently. If natural ventilation is favored by intelligently opening windows, it will keep the air of small buildings reasonably pure without causing discomfort. Natural ventilation can be assisted by constructing buildings with hollow tiles or shafts in the walls arranged to receive outside air and conduct it indirectly to the interior. It can be assisted by placing between the window sashes and frames simple devices that permit free ingress of air and deflect it toward the ceiling, thus reducing its velocity and preventing the impingment of draughts upon persons in the room. Natural ventilation is facilitated by open fireplaces and cowls. But with all these aids, natural forces cannot ventilate large buildings, such as schools, factories, etc. For these, mechanical apparatus is required and ventilation so secured is called artificial.

All systems of ventilation may be divided into three groups: those which provide for the extraction of air, called Vacuum systems; those which provide for the introduction of air, called Plenum systems; and those which provide for both the introduction and extraction of air.

A combination of the plenum and vacuum systems is the best method of artificial ventilation. Where but one method of ventilation can be employed the plenum is superior to the vacuum.

Foul air may be removed from a room in two ways: by suction or by propulsion. When fresh air at a lower tem-

perature than that of a room is permitted to enter, it displaces or forces out the warmer air of the room; and this may be provided for by open shafts that permit cold outside air to enter. Warm, fresh air pumped into a room with sufficient force will displace the foul air.

There are various methods of removing air by suction. It may be done with a suction fan, which is probably the best way. All other devices for the extraction of air create an upward or outward draught in a flue. The upward draught is maintained by heating the flue. This may be done by surrounding it with steam or hot-water pipes, by injecting into the bottom of the flue a jet of steam or water, or by building an open fire beneath it. The last method is the least desirable, because the combustion robs the air of the room of oxygen, is expensive, and can only be employed with comfort in cold weather.

Air shafts, whether for the entrance or exit of air, should be constructed so as to offer the least resistance to its passage; that is, they should be smooth, cylindrical, free of sharp angles and as nearly straight as possible. The fewer branches from the main trunk the better. Those which carry fresh air should be as short as possible and easily cleaned.

The size, number and location of the openings into rooms are of paramount importance. They must be so arranged that the inflowing fresh air does not pass directly to the outlet. The possibility of reversed currents, that is, an up or out draught in the fresh air flue, and the opposite in the foul air flue, must be provided against. Inlets and outlets should be placed on inner rather than on outer walls. The object to be attained is diffusion of the fresh, incoming air to every part of the room before it is extracted. This may require several inlets instead of one, and may necessitate more than a single outlet. In general, several inlets are better than one in a large room. Inlets and outlets should be round or square.

If the fresh air entering a room is cold the inlets should be placed near the ceiling and arranged to deflect their discharge upward and the outlets should be in the ceiling or high as possible. If the fresh air is admitted warm, the inlets may be high or low; if high the outlets should be low and vice versa.

The desired passage of air through supply and exhaust shafts is best secured by revolving screws or fans, because by adjusting the size and tilt of their blades and the speed of their revolution, the amount of air passing through a shaft can be regulated to a nicety under various climatic conditions. In spite of the most skillful construction the passage of air through shafts by natural forces is very irregular, changing with variations of the winds, temperature and being disturbed by rain and snow.

To keep the CO_2 content of indoor air below the permissible maximum of 6 parts per 10,000 there must be somewhat more than 300 cubic feet of room space per individual and a minimum floor area of 25 square feet and 3,000 cubic feet per hr. of fresh air must enter the room.

Fresh air, i. e., outdoor air, is not all pure. In cities the higher above the ground we go for our air supply the more pure it will be. Dust and dirt should be removed from the air before it is passed into buildings by filtering through coarse cloth or flannel. If the air contains noxious gases, these should be removed by washing.

It is easy to determine the amount of air entering or leaving a room by finding the size of the air shafts and the speed at which air passes through them, for the latter an anemometer is used, but one must not forget that the amount of air passing through a room is not necessarily a measure of ventilation, because ventilation is dependent upon diffusion. To determine the degree of ventilation, a sample air should be taken from a room before it is populated and another immediately after a larger number of persons than usual have spent an hour or two in the room. These samples are analyzed and their CO_2 content determined.

By present methods of mechanical ventilation best results are accomplished in rooms having a height of not less than ten or more than twelve feet. It is easier to ventilate those that are regular in shape than those that are irregular. It is more difficult to ventilate rooms of less than 4,000 cubic feet and those of more than 30,000 cubic feet than rooms of intermediate sizes.

In cold weather the problems of heating and ventilating, are inseparably related and it has been found better and more economical to warm fresh air before it enters a room.

HEATING.

Two kinds of heat are made use of in house warming, radiant and convected. Radiant heat, although considered more healthful, warms an object directly without raising the temperature of the surrounding air. It has the disadvantage of utilizing but a small portion of the fuel value and decreasing directly as the square of the distance of the object from the source of heat and thus being available only in small apartments. Open fires are an example of radiant heat.

Heat that is carried from place to place by warm masses of air, water or steam, is said to be convected. Because of the economy in its use and ease of distribution, especially in large spaces, convected heat is most generally used.

Conducted heat, which passes from molecule to molecule of the conducting substance, acts too slowly to be available for house warming. The usual appliances for house warming are open grates, fire-places, stoves and hot air, steam and hot-water furnaces. Electrical heaters are too expensive for common use. Ordinary grates and open fire-places give practically only radiant heat and render available only 7 to 12% of the fuel efficiency. They heat only the surfaces directly facing them of the objects in a room and by reason of the strong current up the chimney are apt to bring in large quantities of cold air from without, thus cause chilling and injurious draughts. Where there is some additional means of heating the air of a room they are valuable in securing good ventilation, if the chimney is controlled by a damper.

Stoves utilize 75 to 80% more of the fuel than open grates, but they do not remove much air and may give off dangerous gases and products of combustion if not properly attended.

The damper in a stove pipe should never be entirely closed.

There should be as much surface exposed as possible without diminishing the combustion, so that there may be increased radiation, and that much air may be warmed moderately rather than a little excessively.

It is often advisable, especially in assembly halls, etc., to surround the stove with a sheet iron cylinder extending from the floor to a height of six or eight feet and to bring in between this and the stove a supply of fresh air from without. This air becomes heated, passes over the top of the cylinder or drum, gives a plentiful supply of convected heat and assists in ventilating the room. Stoves cause an excessive dryness of the atmosphere and give off unpleasant odors when too hot. CO and other gases pass through highly heated cast iron. CO gas is most abundant soon after fresh fuel is put in the stove and its escape into the room must be carefully guarded against by keeping the lids on and the damper open until the blue flame passes away.

Hot air furnaces supply a large amount of convected but no radiant heat. When properly constructed and cared for a hot-air furnace of the right size is a good heater and also a powerful ventilating agent. The large supply of air passing through it into the rooms above must in turn find an exit, either through specially devised outlets or through the innumerable cracks and crevices around doors and windows. If the fire pot is too small, insufficient surface, too intense combustion of fuel will take place.

There should be a considerable expanse of surface never too highly heated so that large volumes of air will be moderately warmed rather than small quantities overheated and burned. Air too highly heated is very dry and offensive; it takes an excessive amount of moisture from the body through skin and mucous membranes, excites glandular activity and increases the liability of catching colds.

A hot-air furnace should be located near the coldest side of a house for it is as difficult to drive the air ten feet against the wind as forty or fifty with it. The floor beneath the furnace should be cemented to prevent the drawing in of soil air. The air supply to a furnace should be taken from outdoor

air and, if necessary to purify it, should be filtered through a screen. The cold air inlet should be screened to prevent vermin or garbage entering and constructed so as to be easily cleaned. It should have a cross section of at least two-thirds the combined sectional area of the hot-air flues, and should be fitted with a damper. Unless unavoidable, registers or openings into rooms for the hot air should not face windows nor prevailing winds.

Hot-air furnaces cannot satisfactorily warm rooms at a greater distance from them than fifty feet and hence are not adapted to heating large buildings or groups of buildings. For extensive heating hot water and steam are used.

Hot water will carry four times as much heat as an equal weight of air at the same temperature.

Low pressure hot-water heating systems are open at the top permitting expansion and hence the water within them can never be much above 212°F. at any part of the system. They have large pipes through which large volumes of water circulate comparatively slowly. Low pressure hot-water systems afford the most economical method of heating dwellings and small buildings. Their range of usefulness is greater than the hot-air furnace, but smaller than that of high pressure hot water or steam.

High pressure hot-water systems are completely enclosed from the air so the water may attain a temperature of 300°F. and it circulates rapidly as they are fitted with small pipes.

Steam heating systems should have radiators with pipes of larger diameter than the supply pipe in order to favor condensation and the consequent liberation of latent heat. Every facility should be provided for the speedy return of condensed vapor to the boiler. The size of supply pipes depends upon the extent of distribution.

Steam and high pressure hot-water heating is especially adapted to the warming of large buildings or the distribution of heat from a central plant.

The amount of radiation surface required to heat a room is determined roughly as follows:

Low pressure steam, presupposing the temperature of radiating steam to be 220°F. to keep room temperature at

70° F. requires:—1 square foot of radiation to 200 cubic feet of air, 1 square foot of radiation to 20 square feet of wall, 1 square foot or radiation to 2 square feet of glass. For low pressure hot water add 60% more radiation. For indirect heating from 50 to 75% more radiation is required than for direct. The above is correct for an outdoor temperature of zero F. 2% less required for each degree above; 80% more required for 20° below zero F. (Taken from John H. Mills).

Heating is spoken of as direct, indirect, or direct-indirect. The direct method is where radiators are placed in the room which is to be heated, without any close relation to the fresh air supply. The direct-indirect method is where radiators are placed in the rooms to be heated and enclosed by boxes connected with the fresh air inlets so that the fresh air passes over them and is warmed before entering the room.

The indirect method is where the radiators are located in a chamber some distance from the rooms to be heated; into this chamber is drawn fresh air sufficient to supply all the rooms. When the air has been heated it is conveyed to the different rooms and both warms and ventilates them.

CHAPTER X.

HOUSING.

In the preceding chapters on personal hygiene, plumbing, drainage, sewage and garbage disposal, heating, humidity, ventilation and water, some of the essential features of proper housing have been considered.

To meet the requirements of health and comfort, certain other things are necessary in houses wherever situated. The first of these is adequate cubic space per individual. Most of the diseases afflicting civilized man directly or indirectly result from either too close association of individuals, or dirt. The greater the number of people inhabiting a given space, the greater amount of dirt accumulating there. When several or more persons together use a sleeping room of 1000 cubic feet capacity, should one of them contract measles, whooping cough, influenza or tuberculosis, it is almost impossible for the others to escape; further, under such conditions rebreathing of vitiated air cannot be avoided. Every individual should be provided the protection of a separate sleeping chamber having at least 500 cubic feet of space. Sleeping chambers, without exception, should be outside rooms with at least one window so situated that sunshine can enter the room a portion of the day and the window should be of such size and so constructed that thorough ventilation can be obtained without dangerous draughts.

At least one chamber in each dwelling should be constructed and furnished so that in case of necessity it could be used as an infirmary in which any member of the household could be isolated and properly cared for if afflicted with a contagious disease. Cleanliness of all parts of a house at all times is necessary for two reasons: First, dirt may be directly harmful; second, it always attracts and favors the multiplication of flies, flees, mosquitoes, bed-bugs, roaches, mice, rats and other disease carriers. To guard against the dangers of ground water and air laden with it cellars must be dry, or where cellars do not exist, the houses must be elevated above the ground high enough to permit free circulation of air.

In hot climates and where some days in summer are very hot, no one should be compelled to sleep directly beneath a roof; an air space should intervene between the roof and ceiling of the upper chambers.

Screening of windows and doors to exclude flies and mosquitoes has a value in protecting against disease that cannot be denied.

Separate dwellings for each family are much better than apartment houses. The great majority of prosecutions for rape committed indoors, that come before the courts, originate from overcrowding of apartment houses. Instinctively we know, that a high quiet location, where the sun shines through clear skies and heat is tempered by verdant trees, where the atmosphere is pure and sweet and our neighbor's house some feet away, is far better than a spot hedged in by tall buildings, bounded by dark narrow streets into which sunlight penetrates poorly and only for a few hours each day; a spot continually vibrating with the noise of traffic and industry and bathed in an atmosphere laden with smoke or reeking with obnoxious chemical odors. The former supplies many of the elements that build up and develop physical and mental strength and foster that tranquillity necessary to the conception of our proper relationship to humanity and civilization. The latter constantly exerts an opposite detrimental influence.

The problem of securing proper housing requires the education of the rich and powerful—not the poor. No man lives in misery through choice. Solution is economic and requires the most convincing presentation of the facts established by modern medicine. First, that improper housing of the poor does stunt their development, decrease the value of their labor and cause disease. Second, that the expense incurred through disease is borne in part by every member of society and to some degree endangers or injures all. Third, that civilization as a whole directly benefits by the correction of any condition that deliteriously affects the health of any portion of a community no matter how small or limited that portion may be. Fourth, no matter how great the initial expense of obliterating sources of disease may be, the ultimate material gained always justifies and makes profitable such expenditures.

CHAPTER XI.

INDUSTRIAL HYGIENE.

Occupations induce disease by compelling workmen to inhale irritating or poisonous gases, vapors or dust; by causing the absorption through the skin or mucous membranes of injurious substances. Toiling where either atmospheric pressure or temperature is abnormally high or low or frequently changing from one extreme to the other, is deleterious and frequently injures or destroys life.

Occupations that require excessive use of certain organs, as the eye, vocal organs or various groups of muscles; others that enforce constrained attitudes and sedentary life, and employments necessitating exposure to mechanical violence, all entail disease, injury or death. The amount of morbidity and mortality so caused is enormous; much of it is preventable.

The most dangerous occupations are those which cause the continuous inhalation of dust, vapor or gas. From 25 to 75% of the people employed in such occupations die of pulmonary affections. Principally tuberculosis. Grinders, file cutters and cutlers suffer most; under the most favorable circumstances 70% of them die of respiratory diseases according to the Health Department of Sheffield.

Sulphur dioxide gas, used as a bleaching agent in the manufacture of straw hats, etc., may cause disturbance of respiration or digestion. Such occurrences are minimized by providing good ventilation and free access of air to the workroom.

The same applies to nitric acid fumes.

Hydrochloric acid fumes, as given off in the manufacture of soda, are but slightly dangerous; in the operation of sealing and capping canned products the constant inhalation of these fumes frequently gives rise to nasal inflammation which may result in ulceration and perforation of the nasal septum. Annointing the nose, within and without, several times a day

with vaseline will prevent the affection. Chlorine is very injurious, nearly half the men engaged in manufacturing chlorinated lime become affected. Constant inhalation of air impregnated with chlorine, produces bronchial catarrh, destroys the sense of smell, predisposes to pneumonia and tuberculosis, brings about a cachectic appearance and a prematurely aged expression.

Those who work in chlorine are subject to attacks of violent coughing associated with extreme dyspnoea, dilatation of the eyes, blueish pallor of the skin, reduced temperature, small pulse and cold sweats. Such attacks are rarely fatal. If removed to an atmosphere of pure air and properly treated, the person usually recovers in a few hours, but complete health seems never to be restored to those who have become subject to such attacks.

Men who must engage in this kind of work should be selected from the physically fit and allowed to work only four hours a day. No one should be compelled or permitted to live constantly in an atmosphere odorous with poisonous gases.

Carbon monoxide is present in the air of gas works, iron smelters, coke and charcoal furnaces. Acute poisoning with this gas causes headache, dizziness, roaring in the ears, profound muscular depression, nausea, vomiting, unconsciousness and asphyxia.

The pulse is at first accelerated, then becomes slow; respiration is slow and stertorous and the temperature falls 3° or 4° F.

Convulsions may occur or paralysis of the sphincters and other groups of muscles.

If the patient escapes death, grave mental and physical depression often ensues. Loss of appetite is common, constipation and various paretic conditions may develop. Convalescence may be protracted.

Slow or chronic carbon monoxide poisoning is marked by headache, dizziness, loss of memory, diminution of mental activity, slow pulse and respiration, nausea and sometimes vomiting and purging.

This gas combines with hemoglobin which makes the blood almost black.

Carbon Dioxide which is one of the constituents of choke damp of mines, causes difficult respiration and weakness in small amounts. Large amounts cause loss of consciousness after which, if the patient revives, headache, drowsiness, depression or physical excitement may occur. Acute poisoning with unconsciousness is followed by prompt recovery upon removal of the patient into pure atmosphere, in nearly all cases. Vinters, distillers, brewers and yeast makers may suffer from this affection. When CH_4 forms and mixes with air in the proportion of 6 to 10 volumes, it becomes a violent explosive and if ignited, the oxygen is consumed, resulting in the formation of CO_2. Such occurrences are not uncommon in deep mines, pits and wells. Of course, to be present at the time of such an explosion is disastrous and the carbon dioxide atmosphere following such an explosion will asphyxiate workmen caught in it.

The dangers of choke-damp can be averted by thorough ventilation and the use of the Davy safety lamp which gives warning of the presence of the noxious gas.

Hydrogen sulphide gas is apt to accumulate in privy vaults, cesspools and sewers. It may be exhausted by means of hot water or irons or anything that will expand the gas and cause it to rise and be replaced by pure air.

Before anyone attempts to enter such places as may contain poisonous gases the atmosphere should be tested by lowering a cat or dog into them and allowing the animal to remain there for fifteen minutes. If it shows no ill effect when removed, man can safely enter.

Bisulphide of carbon is used in the arts principally for extracting oils from seeds and fatty bodies and in the process of vulcanizing India rubber. Inhalation gives rise to headache, pains in the joints, formication, itching and cough. The person becomes more talkative than formerly, shows interest in matters that previously never interested, has increased sexual desire and urine that possesses a faint odor of bisulphide of carbon. After a time these signs of poisoning are

replaced by others. Profound depression, melancholy, discouragement, impariment of memory, vision, hearing and impotence, associated with numbness of the fingers and areas of anesthesia mark the later stage.

This condition rarely proves fatal. Improvement takes place under favorable circumstances but restitution to normal is uncommon.

Iodine and Bromine are both irritating and cause headache, conjunctivitis and imflammation of the entire respiratory mucous membrane.

Those who work with these irritants may suffer temporary loss of consciousness and develop bromine asthma or iodine cachexia.

Turpentine may cause diseases of the respiratory tract and result in tuberculosis; it may produce strangury and blood in the urine and may bring about disturbances of the digestive canal.

LEAD POISONING.

Lead may enter the body in poisonous amount through the skin from contact, through the respiratory tract from air laden with the vapor or dust of lead; through the gastro-intestinal tract, from the ingestion of food or beverages containing lead.

Lead poisoning attacks those engaged in roasting and melting lead ores, in manufacturing white and red lead, in type making, painting and the numberous other occupations in which the metal is largely used.

Sometimes as many as 50% of those engaged in making white lead and sugar of lead are afflicted. Lead poisoning may be acute or chronic. Its onset may be sudden or insidious. The manifestations, which are numerous, in some cases are characteristic—almost pathognomonic—in others, the relation of cause and effect is obscure. Acute poisoning is usually manifest by the syndrome known as lead colic or painters' colic. There is nausea, abdominal pain and tenderness, vomiting, constipation and diarrhoea. Colic is the earliest manifestation of poisoning in most cases—acute and chronic

—and is apt to recur from time to time during the course of chronic plumbism.

The blood is always affected. Anemia develops before symptoms occur and when plumbism has existed some time there is marked pallor of the skin. Besides colic, chronic lead poisoning occurs in three forms: Lead Encephalopathy, in which the central nervous system is profoundly affected; the neuro-muscular form marked by wrist-drop; and third, those cases distinguished by profound cachexia, albuminuria, rheumatoid joint pains and early decrepitude. The picture presented by an individual, who is extremely pale, who has a blue line at the margin of the gums, whose wrist drops, whose pupils and knee jerks are unequal, is pathognomonic of lead poisoning.

The mortality of this disease is high; complete recovery is the exception, not the rule.

By the observance of proper precautions, the incidence of lead poisoning and its after effects can be greatly reduced.

Women, especially young women, are more susceptible than men and hence should be excluded from all occupations that expose to plumbism. Anemia is the first evidence of lead poisoning in many cases. Routine examination of the blood should be made at frequent intervals of those who work in lead, and the discovery of anemia should debar one from further participation in such work. Those who develop lead poisoning as a result of occupation should not be permitted to resume the same occupation after recovery.

Thorough ventilation of work rooms, short hours of labor, the use of masks that exclude vapors and dust, the wearing of gloves and overalls that are frequently washed and renewed and frequent bathing of the entire body are all measures that lessen the occurrence of lead poisoning.

MECURIAL POISONING.

Smelters of mecurial ore suffer most severely; their average age at death is 45 years. Mirror makers are prone to develop salivation, mecurial tremor, erethism and tuberculosis.

75% of those who coat mirrors with mercury alloy die of pulmonary tuberculosis.

Women suffering from mecurial poisoning are apt to abort if pregnant and 65% of living children born of such women die before one year of age. Those engaged in quicksilver mines, fire gilders, fulminate makers, and those engaged in making certain kinds of instruments and hats may develop mecurial poisoning.

The danger of mecurial poisoning can be reduced by keeping the floors of work rooms moist with ammonia water.

Zinc or copper vapors or a combination of the two, given off by brass, give rise to severe pains in the back, lassitude, chilliness and rigors that last 15 minutes or longer, followed by free perspiration and deep sleep, the condition called brass founders' ague. 75% of brass foundrymen experience such attacks, together with headache, cough and soreness of the chest.

There is a form of chronic poisoning to which zinc workers are susceptible that is marked by hyperesthesia, formication, burning of the skin of the lower extremities and diminution of the muscular sense.

Sometimes this is followed by paresis.

Anilin vapor is poisonous when inhaled in a concentrated form. There is an acute form of the disease marked by anorexia laryngeal irritation, slow respiration and increased pulse and cold pale skin; chronic poisoning affects the entire system, the nervous system, digestion and the skin suffering the most.

Persons poisoned by anilin are subject to convulsions and loss of consciousness; they may go into coma and die. Anilin is used in making explosives, such as robusite.

Phosphorous poisoning occurs chiefly among matchmakers. It is less common than formerly because of improved methods of manufacture and the observance of hygienic precautions.

Phosphorous gives off poisonous fumes at ordinary temperatures provided the air contains moisture. Red or amorphous phosphorous gives off no fumes under usual con-

ditions. Those who have cavities in their teeth are thereby rendered more susceptible to intoxication than others, and if afflicted, have necrosis of the jaw bones.

Thorough ventilation of work rooms, rapid drying of matches immediately after they are dipped, and strict attention to the workers' teeth, frequently cleansing and exclusion from work of those having cavities, are measures that greatly lessen the occurrence of phosphorous poisoning.

The inhalation of wood alcohol fumes may diminish vision or produce blindness which may be temporary or permanent.

PNEUMOCONIOSIS.

The constant inhalation of any kind of dust for a long time causes catarrh and emphysema and usually induces pneumonia or phthisis.

Metallic dusts are the most harmful.

Arsenic, lead, steel, stone and coal dusts in the order mentioned are the most injurious.

Pigment grinders, nailers, cutlers, file cutters, needle polishers, glass cutters, stone cutters and coal miners have an average duration of life of about 40 years, and nearly one-fourth of them die of tuberculosis. Animal dust is slightly more injurious than vegetable dust; in addition, it may carry the spores of anthrax and germs of other diseases.

The morbidity and mortality among those engaged in occupations that constantly fill the air with dust can only be reduced by limiting as far as possible the amount inhaled. Much has been accomplished in this direction and more remains to be done. Workmen who toil in a dusty atmosphere should wear masks that filter the air they must breath. The period of labor should be short. Where it is possible to reduce the amount of dust in the atmosphere, by attaching suction tubes, fans or pumps to machinery, it should be done. The observance of such precautions does materially lessen the danger.

Occupations involving exposure to extremes of heat, such as engine drivers, stokers, firemen, coal passers, oilers, steel mill workers, foundry men, sugar refiners, glass makers,

cooks, bakers and miners, predispose to heat exhaustion, thermic fever, catarrhal and rheumatic troubles, kidney diseases and skin eruptions. The effect of high heat alone is exhaustion. But in the occupations mentioned, high temperature is associated with vitiated air, dust, irriating fumes and dampness.

Sugar refiners work in an atmosphere saturated with moisture at a temperature of more than 100° F. This combination of heat and humidity is a great tax on the human body. It cannot be tolerated for more than a few hours at a time, and heat stroke often afflicts those who were normal upon entering such an atmosphere, before they have labored an hour.

Sudden chilling of the body caused by rapid passage from superheated work rooms or factories into the cooler outside air is dangerous and should be guarded against.

Occupations necessitating exposure to dampness, or to cold and dampness, as cold storage workers, ice manufacturers, ice men, boatmen, fishermen and trench diggers induce rheumatic, bronchial and pulmonary troubles but do not as a rule shorten life.

Exposure to abnormal atmospheric pressure frequently causes serious illness or death. No discomfort is felt upon passing from normal into a greater than normal atmospheric pressure; untoward effects are manifest upon return from high pressure to ordinary atmospheric pressure. The more abrupt the change, the more likely will symptoms occur.

Caissons are inverted watertight boxes used by those working at great depths or under water. They are kept full of air by pumping it into them until the air pressure within is equal to the surrounding pressure.

Caissons are entered and left through chambers called locks, which serve two purposes; they make entry and exit possible without disturbing the pressure within the caisson and permit one to gradually change his atmospheric pressure.

Caisson workers are so frequently stricken after withdrawing from the high pressure that the phenomenon is termed Caisson Disease.

It is marked by headache and severe pain in the ears, epigastrium, back and legs. There is a variable amount of muscular paralysis, the lower extremities being most commonly involved; sometimes there is paralysis of the arms, bladder or rectum. The staggering gait caused by paralysis is so often observed that Caisson workers call the disease, "The Staggers" or "Bends." Vomiting may occur. The pulse is rapid and the patient sweats. Death may occur a few minutes after onset, but complete recovery is the rule. The illness runs a short course, symptoms usually subsiding in a few hours; some cases persist for several day or weeks.

The occurrence of caisson disease is minimized by employing only healthy, robust, temperate men; by examining them each time they are to enter the caisson; by locking them in and out slowly according to fixed rules, and by limiting such labor to a few hours each day. In locking out, one minute should be allowed for each 6 pounds of pressure within the chamber. When the pressure within a caisson is 20 pounds, one four-hour period or two three-hour periods, separated by an interval of several hours constitutes a maximum day's labor; when the pressure is 30 pounds, two hours each day should be the limit of labor; 40 pounds pressure is generally considered the highest in which man can live, and at that pressure only 30 minutes labor per day is required. Occasionally men have worked at 44 pounds pressure without ill effect.

Occupations involving constrained attitudes, and those necessitating over-exercise of parts of the body, induce deformities and injure health. Bench workers of all sorts are inclined to stooped shoulders, curvature of the spine and restricted respiratory excursions of the chest which predisposes to tuberculosis; conspicuous among these are harness makers and shoemakers; they are subject to more or less constant pressure of shoes, lasts, horse collars, etc., against the chest and abdomen which sometimes causes a funnel-shaped deformity of the chest and occasionally seems responsible for cancer.

Writers' cramp is a disease of the nerves and muscles of the forearm caused by too much writing; overworked telegraphers, engravers, seamstresses and pianists are subject to similar localized paralyses and tremors.

Occupations involving sedentary life induce sluggishness of the vital organs and general debility which lessens the power of the body to withstand disease or injury and lessens the power of combating illness.

CHAPTER XII.

SCHOOL HYGIENE.

The protection of the health of students, especially immature ones, necessitates strict observance of sanitary principles in the location and erection of school buildings; the heating, lighting, ventilating and cleaning of them and the selection and arrangement of desks, seats, black-boards and other furniture. Of equal importance is the proper adjustment of the curriculum to the mental and physical power of the students and the establishment of proper relationship between pupils.

Hygienically, these things take precedence over such others as routine inspection of persons for mental and physical deviations from normal, even though no one dissents from the belief in the desirability of the latter.

Only such sites should be selected for school buildings as are sufficiently elevated to insure good drainage of sewage collected in the buildings, surface and rain water. The grounds should be of sufficient extent to insure free access of pure air and sunlight to all rooms and provide ample recreation space for the children. Proximity to marshes, stagnant pools, factories, tall buildings, railways and other unsanitary surroundings should be avoided.

School buildings should be not more than three stories high and fireproof. Where fireproof structures are impossible, tower or built in fire escapes are the best. Corridors should be wide straight and well lighted and all doors should open outward to permit ready egress and guard against the danger of accident in panic. Smooth, accurately joined floors when coated with oil or paraffin are impervious to dust.

All interior walls should be smooth and coated with lime or water colors which permit transpiration of air instead of coated with impervious metallic paints. Walls should be tinted neutral gray, light blue or green and ceilings white.

Sharp angles and corners which collect dust should be conspicuous by their absence.

Class rooms should be 30 feet wide, 45 feet long and 12 feet high. The windows should extend from the height of the pupils shoulders to the ceiling and their area should be at least one-fifth that of the floor. Illumination is a difficult problem. Illumination from above through sky-lights is best but can only be provided in a few rooms. Light from the North is best for side illumination; insofar as possible, class rooms should have windows on two sides and the desks and seats should be so arranged that light enters from the back and left side, not from the front or right side, because light entering the front of a room makes a glare that injures the eyes, an illumination from the right casts a shadow of the pen in writing that interferes with good vision.

If a room has windows on one side only they should be on the left and the room should not be so wide that the right side of it is poorly illuminated.

Properly shaded electric lights are to be preferred to gas jets for artificial light.

Cloak rooms should be well lighted and ventilated and of sufficient size and so arranged that each pupil's garments are free from contact with the garments of others. It is desirable to provide a separate cloak room for each class so as to limit the possibility of dissemination of vermin and disease.

Black-boards should be lusterless and attached to the wall at an angle instead of flat against it to preclude reflection of light into pupils' eyes.

The height of seats must correspond with the length of the occupants legs.

The backs of seats should be concave above and convex below so as to conform with occupants backs and should be sufficiently high to support them. Desks should have an inclination of 15° and be of such a height that one sitting erect is in the most convenient position to write. If they are either too high or low they induce curvature of the spine. Single desks are preferable to double desks or solid rows of desks, and they should be so arranged that each pupil has

not less than 30 square feet of floor space. Aisles should be of ample size to permit passage without contact with occupants of desks.

An abundant supply of good drinking water should be provided.

Facilities for proper ventilation and heating are of prime importance.

Water closets should be in a separate building, where there is no public sewer; where there are sewers, water closets should be in the school-house, each floor being equipped with a sufficient number for the pupils of that floor, and should be so located that no odors escape into corridors and class rooms. They should be under the supervision of teachers and kept clean. Laterins should not be permitted; each seat should independently empty into a drain pipe.

Routine inspection of school buildings and school children by competent medical inspectors would be beneficial to the students and community.

CHAPTER XIII.

PROPHYLAXIS.

Race Culture.

By the observance of natural laws and taking advantage of what is already known regarding the etiology of diseases, it is possible to reduce the occurrence of disease, reduce mortality and elevate the physical and mental development of man. More can be accomplished by preventative medicine than by theurapeutics and surgery and the field of application expands as our knowledge of etiology increases.

Prophylaxis is consequently worthy of our most careful attention.

It inspires enthusiasm that sees in preventative medidine a panacea. Such enthusiasm is to be guarded against because it lessens the value of a good thing and exposes its wearer to ridicule. Preventative medidine is not a panacea; there are well established limits to its power of curtailing disease and fortifying health. Failure to recognize these limits is stupidity; attempts to surmount or defy them are disastrous.

The limits referred to as irremovable may be grouped under two heads:

1. Man's willful defiance of recognized law and a lack of power to prevent such defiance.

2. The limitation of the practice of medicine to the relief of suffering, together with the preservation of life.

Probably more misery, deformity and death are produced by venereal diseases than by any other cause. Gonorrhoea and syphilis are usually the result of unlawful venery. They produce an innumerable variety of loathsome and painful lesions in the defiled and pass with the germ of life to blind and blight and make idiots of generations yet unborn.

Education has been suggested as a means of preventing such terrible things, particularly instruction in sex hygiene given to adolescents.

Fornication and adultery are not peculiar to either the ignorant or the young, their effects are as commonly found in medical students as in others. A knowledge of hygiene does not confer the proper attitude; it does not have the desired effect.

Antiseptic irrigations. inunctions and baths immediately after unlawful intercourse have been advocated as means of avoiding venereal diseases. A thorough washing of the external genitals with hot $HgCl_2$ solution followed by an inunction of calomel ointment and an injection of argyrol or $AgNO_3$ into the urethra does reduce the incidence of infection, it lessens but does not preclude the danger, and sooner or later those who frequently have occasion to resort to such measures become infected just as their unwashed brothers.

All sane persons capable of sexual intercourse know promiscuous indulgence is unlawful. The most intelligent, educated and experienced know the only sure way of avoiding infection is to abstain. Yet with all this knowledge and in spite of prophylactic inunctions and injections, syphilis and gonorrhoea propagate.

Obviously legislation and therapeutics cannot eradicate it. Early marriages and a sense of morality and justice that precludes exposure of self and others to the source of infection is the only preventative extant.

While the securing of social conditions conducive to early marriage and the instillation of morality are not our vocations in justice and in the interest of public health, it is our duty to refrain from giving prescriptions which are useless as preventatives and dangerous in that they inspire a false sense of safety and tend to increase rather than diminish what has been called our social evil.

All facts bearing on the case indicate that proposed legislation, making venereal diseases reportable, would be productive of little good.

It is very doubtful whether restricting marriage license to healthy persons would protect the innocent and such restrictions might easily produce harm. Much benefit might be

derived by encouraging voluntary submission to physical examination before marriage.

Foetal morbidity and mortality and the complications of pregnancy can be greatly reduced by any means that will lead women to realize the responsibility and common danger of gestation and to practice the hygiene of pregnancy, and make proper nursing and medical attention available to all.

Next to venereal diseases and foetal mortality, most preventable deaths occur among infants less than 2 years of age and the majority of these deaths are the result of improper feeding. Human milk is better adapted to the requirements of infants than any other food. It is more easily assimilated and less apt to cause intestinal disturbances. It is more likely to be given properly and less apt to carry disease; in addition, human milk imparts substances which tend to protect children from infectious diseases, a boon to life lacking in artificial foods.

Every effort should be made to secure human milk for children. Some must take their chance on artificial food; most children so fed are given cow's milk and the mortality among them is in inverse proportion to the cleanliness of the milk; the fewer bacteria in the milk, the smaller the mortality.

Various observers have found that from 3 to 13% of the milk sold in cities contains tubercle bacilli; none of it is free of bacteria. A considerable portion of tuberculosis in children is traceable to milk.

In 1910 there were 200,000 preventable deaths among children less than two years of age in the United States, most of them due to improper accouchment and improper feedings.

Far less numerous and of less importance is the number of grossly defective children born. By grossly defective, we mean children whose physical or mental constitution is such that they cannot under the most favorable circumstances acquire the average degree of development and hence are apt to become detrimental to society. Some parents are more likely to bring forth such children than others.

Normal parents who lead hygienic lives beget the greatest number of healthy children; even such parents are occasionally given grossly defective children.

The proportion of defectives among the children of persons distinguished in art, science and trade, so-called captains of industry, is greater than among children of ordinary parentage.

The proportion of defectives among the children of alcoholics, the tuberculous, epileptics, neurotics, imbeciles, syphilitics and inveterate criminals is very great, but these latter beget a very small number of children, most of whom die shortly after birth.

The alleged increasing proportion of defective children has filled some with consternation. To correct the evil they advocate sterilization or castration of persons especially apt to beget defective children. Any attempt to do so would fail, first, because access could be gained only to an unimportant few; second, because the important forces that tend to produce degeneracy are extra corporal, such as the prevailing sense of morality, honesty, duty and success.

Legislation that can increase the general welfare is most desirable, but before advocating any legislation in the interest of public health, we must first accurately locate the cause of evil, be sure our method of treatment is efficacious and careful no element of harm is included in the proposed legislation. We must remember our calling is to relieve human suffering, together with the preservation of life and that we are not executioners.

Then, before placing much confidence in the power of man-made laws to control or eradicate venereal and kindred diseases, it might be well to reflect that God Himself made the Ten Commandments and they are broken every day.

TYPHOID FEVER.

During the course of typhoid fever, the bacilli enter the blood stream, impregnate the intestinal mucous membrane and escape from the body in the urine and feces. Sometimes typhoid bacilli lodge in the gall-bladder, occasionally in bones or joints, and remain alive and virulent for years. If perchance, they produce inflammation, necrosis and open sores, even years after the fever subsided, the discharge is capable of spreading the disease.

The feces of many people contain typhoid germs for a long period after recovery from fever and there are some who have never been ill who harbor the organisms and pass feces capable of spreading infection.

Such discharges ejected into rivers or streams or deposited on land from whence it is washed into them, prepares the water to convey typhoid fever to those who may drink it or eat or drink anything washed by such water or contained in vessels washed in it.

The discharge from one patient is sufficient to so contaminate a stream as to cause an epidemic several miles distant where the water is used for drinking and domestic purposes.

Milk placed in cans or bottles washed with polluted water frequently is the source of typhoid fever, as are oysters from such streams and vegetables and fruits washed in them.

Typhoid carriers pollute their hands in the toilet of defecation. Nurses and attendants of the sick frequently pollute their hands, and all such are capable of planting the germs upon anything they touch and thereby spread the disease. The busy little fly that wets its feet in the urinal and washes them in the milk, or flies from dung to a sugar loaf, carries the germs from one to the other, industriously aiding the hand of death.

Where typhoid is endemic the water supply is nearly always polluted, and purification is indicated. Dreschfeld found that 70% of epidemics are due to the water supply, 17% to milk and 3% to other foods. It would therefore seem that about 10% are due to carriers.

When an epidemic of typhoid suddenly occurs in a community the cause must be promptly detected and removed. The water supply, milk supply and food should be simultaneously examined. When there is an explosive onset of typhoid in a community previously free of the disease there are circumstances which indicate the mode of infection. For instance, a recent epidemic in Pennsylvania occurred in a small town, all of the inhabitants of which derived their food from a common source. One-half the town derived its water

supply from a storage basin; the other half did not. All the cases of typhoid occurred among those who used the basin water. Health officers directed that no more water from the basin be used until it was boiled, and when this precaution was observed no new cases developed.

Investigation disclosed the following facts: Several months prior to the epidemic a man who lived in a hut about two miles above the basin had typhoid fever and his discharges had been thrown upon the ground, and later there were heavy rains that washed the refuse from the ground and drained into the storage basin.

Gertner, in studying an epidemic, observed that all the cases occurred among those who had eaten meat from a certain shop, and further investigation disclosed the fact that a diseased cow had been the originator of the epidemic.

Another observer in seeking the source of a Chicago epidemic found that all the houses in which the disease occurred derived their milk from the same dairy, where the cans had been washed with polluted water.

A recent epidemic in Jersey was caused by milk that had been handled by a man who had never been ill, but was found to have typhoid bacilli in his stools. Typhoid Mary, of New York, was a notorious carrier, and caused many cases while engaged as a cook.

Notwithstanding the indisputable evidence that 70% of typhoid epidemics have been caused by drinking water, the bacillus usually cannot be isolated from water, even though the water is known to contain it. The same may be said of milk.

Typhoid bacilli can always be discovered in the feces of typhoid carriers, and occasionally in infected foods.

The important permanent precautions against typhoid are: First, prevent the deposit of human excreta upon soil or into water or upon or into any receptacle from which it can escape into soil or water; second, slow sand filtration or boiling of polluted water and water that may be polluted before drinking or using for domestic purposes; third, prevent contamination of food; fourth, prevent carriers from

engaging in occupations in which they are especially apt to spread infection; fifth, frequent examination of water, milk, sewage disposal and dairies; sixth, immunization of healthy people by bacterial vaccine; seventh, examination of urine and feces of all typhoid patients before discharged as cured; eight, extermination of flies.

The important precautions to be observed during epidemics are:

(1) Sterilization of all water and food before using until cause is located.

(2) Disinfection of all discharges from patients and isolation of patients and their nurses.

(3) Bacteriological examination of feces from suspected carriers.

(4) Immunization of those not affected, especially troops and tourists about to take the field.

(5) Protection of food from flies.

Immunization is produced by the comparatively harmless procedure of injecting dead bacteria into the subcutaneous tissue.

The hygienic precautions that protect against typhoid are sanitary drainage, purity of water, milk and food, and avoidance of contact with unhealthy persons and dirty flies. These precautions also reduce the occurrence of a great many other infectious diseases, especially those of the gastro-intestinal tract, such as cholera, dysentery, summer diarrhea, bovine tuberculosis, hook-worm disease and tape-worm infestations.

MALARIA AND YELLOW FEVER.

Both these diseases result from the bite of infected mosquitoes; they can be contracted in no other way, and the problem of prevention narrows itself to preventing mosquito bites.

By studying their habits and vital necessities, we are enabled to avoid their assaults and exterminate them. Screening houses and exposed parts of the body, anointing the face and hands with substances obnoxious to mosquitoes, such as

coal-oil and oil of citronella, and remaining indoors after sundown, are measures usually successful in preventing the insects from inoculating their virus. An additional precaution to neutralize the effect of possible bites is the daily consumption of from 2 to 10 grains of quinine during the time one is in an area infested with mosquitoes.

The removal of all vegetation within a radius of 100 yards around dwellings greatly reduces the number of insects that may gain access to them, since mosquitoes cannot ordinarily fly that far without resting.

Mosquitoes flourish where there is stagnant water; they require it to propagate; hence they can be exterminated by covering all storage barrels, vats, wells, etc., draining or filling in swamps and depressions, covering ditches, disposing of sewage and garbage and oiling all exposed bodies of water that cannot be otherwise disposed of. Where these measures have been thoroughly carried out, malaria and yellow fever have been banished from districts where formerly they were humanity's greatest scourge. These same precautions are equally efficient in avoiding other mosquito- and fly-born diseases, among which may be mentioned Relapsing Fever.

DIPHTHERIA.

Diphtheria bacilli occur in the throat or nose of persons suffering with the disease, in the nose and throat of many convalescents, and some who have never been ill. Such persons may transmit the disease by contact, by close association or by exhaling or expectorating bacteria into air or milk.

Isolation of those suffering with the disease and of carriers until diphtheria bacilli are no longer in the nose or throat is imperative. Avoidance of crowding, especially indoors and the maintenance of free ventilation in buildings, especially school-rooms and work-shops, lessens the possibility of transmission of germs.

Epidemics can frequently be traced to carriers, and an attempt to detect them should be made whenever diphtheria occurs.

Those who have been or are about to be extraordinarily exposed to infection, such as nurses and inmates of institu-

tions, where the disease prevails, should be given prophylactic injections of anti-diphtheritic serum, mouth washes and perhaps, tonics.

The mortality of diphtheria can be greatly reduced by the administration of diphtheria antitoxin. The efficacy of this agent is greatest when given early. Early diagnosis is facilitated by, frequently dependent upon, microscopic examination of smears or cultures taken from the patient's throat.

PNEUMONIA.

Pneumonia, due to the pneumococcus, has variable degrees of contagiousness. Sometimes the tendency to spread from one person to another is so slight as to be regarded as nil; occasionally it attacks one person after another in a house in rapid succession, creating a small but dangerous epidemic. Its proclivities in any particular case cannot be forecasted, and hence pneumococcus pneumonia should always be treated as a dangerous, contagious disease.

The organisms are abundant in the sputum of the afflicted, and in spite of care, the sputum is apt to get upon any of the patient's utensils, so everything that comes in contact with him should be disinfected before it is put into general use.

There are many healthy persons who continually harbor the pneumococcus in their mouths. It is not yet established whether or not these carriers disseminate the disease. They can be freed of the pneumococci by the administration of bacterins.

PLAGUE.

Plague is a highly contagious disease that tends to occur in epidemics. It is caused by the bacillus pestis, which may be given off in the patient's sputum. Rats, squirrels, fowls and fleas become infected and transmit the disease to man.

Isolation of patients and disinfection of their sputum are necessary precautions.

Protection from flea bites by wearing proper clothing and netting is a valuable precaution in districts where the disease prevails. Extermination of rodents and insects is efficacious

in preventing the spread of plague. Haffkine's vaccine confers immunity and is administered to those exposed to infection or about to enter a district where plague prevails.

Vaccination does not confer immunity against the pneumonic form; this is protected against by wearing a mask while exposed.

SMALL-POX.

Small-pox contagium may travel through the air a considerable distance and still retain its infectiousness. It may be transmitted by a third person, by direct contact and by fomites.

The practice of vaccination against this disease in early childhood and again whenever danger of infection occurs, confers immunity and should be a universal practice.

The strictest isolation of small-pox patients and suspects is imperative, so is disinfection of all things exposed to contamination, but no measure has been discovered so valuable in preventing the occurrence and spread of this disease as vaccination.

WHOOPING COUGH, MEASLES & SCARLET FEVER.

The specific contagium of these diseases has not been discovered. They are much alike in the manner of transmission from one person to another.

From the time the first symptoms appear, perhaps earlier, the saliva and sputum of patients is infectious. Measles is perhaps the least contagious of the three and seems to require direct contact for transmission. Whooping cough may be contracted by direct contact or by confinement in a room with a person having the disease.

Scarlet fever may be transmitted by contact, by the desquamations, by milk and fomites. There are good reasons for believing these diseases are sometimes disseminated by carriers, apparently healthy persons who harbor the specific contagium in their mouth, nose or throat and exhale and expectorate infectious matter.

The contagium of scarlet fever is much more tenacious and survives outside the human body much longer than that of either measles or whooping cough. The indirect morbidity and mortality of these diseases is great. It is amenable to treatment and can be markedly reduced by proper attention. In many cases the diseases can be ameliorated and shortened by the administration of autogenous bacterial vaccines and the occurrence and severity of complications and sequelae reduced. All of which tends to lessen the spread of infection.

After an attack of measles, whooping cough or scarlet fever, vitality is low; resistance is weak, and susceptibility to diseases of all sorts is great. At this critical time good food, fresh air, rest and proper clothing will lead to complete recovery; many, if denied them, fall victims of tubercular or similar infections and die.

Convalescents, especially if children, require good food, fresh air, rest and proper clothing. The protection of the healthy necessitates isolation of whooping cough, measles and scarlet fever patients during their illness and as long afterward as they are capable of transmitting the disease; disinfection of the school-room in which they may have been during the period of incubation and disinfection of their clothing, utensils and place of confinement, after recovery.

These diseases occur commonly among children, a fact which emphasizes the desirability of sufficient cubic space per individual to prevent unnecessary contact of pupils in school rooms; the necessity of good ventilation and cleaning of such rooms and the danger of using the school books, pencils, etc., of others.

TUBERCULOSIS.

Tuberculosis is one of medicines greatest problems. Two types of the disease occur in man, human and bovine. Bovine tuberculosis is contracted almost exclusively by children on a milk diet; hence its eradication simply requires the abolition of tubercular milk as a raw food.

Tuberculosis is a specific disease caused by a bacillus which is very resistant to germicides. It withstands freezing

drying and high temperature and retains its virulence for a long time outside the body. In the body it may lie dormant for years and then become destructively active.

The disease may be divided into two categories, open tuberculosis and closed tuberculosis. When the seat of activity is confined to parts of the body that have no external openings, such as the abdominal cavity, lymph glands, bones and joints, the bacteria cannot escape; the affected persons do not give off infectious matter, do not disseminate the disease and are therefore said to have closed cases of tuberculosis. When the infection attacks parts that do have external openings such as the lungs, tonsils, rectum and skin, and when fistulas open, glands suppurate or joints are perforated infectious material may escape from the body; such are open cases of tuberculosis.

Persons having open tuberculosis are a menace to health. Their disease causes frequent and profuse expectoration of sputum laden with tubercle bacilli. If any of it escapes destruction, it dries and liberates the microbes, which then float through the air, settle on food and clothing and finally gain access to a human host.

Victims of pulmonary tuberculosis exhale air laden with bacteria and their breath plants the germ of death on everything it touches. The hands of such persons, from frequent contact with the mouth, handkerchiefs and sputum cups, are usually covered with the germs and pollute whatever they touch.

Open tubercular abscesses exude infectious matter. It is obvious that persons with open tuberculosis endanger the life of others. This danger may be lessened by the following means:

Expectoration of tubercular sputum into sputum cups that are frequently cremated and replaced, individual utensils of all sorts for the tuberculous that are not allowed to come in contact with others, and the sterilization of them as frequently as is practical; restraint on the part of the tuberculous from unnecessary contact with other persons and from the use of other persons' linen, clothing, eating utensils, tools,

etc., frequent bathing, especially of the heads, the avoidance of occupations that extraordinarily endanger others as nursing and teaching.

Even when a patient is situated in a hospital and earnestly endeavors to protect others from his disease, he cannot entirely do so nor can his attendants. Some sputum will miss the cup; some of it will get on his clothing, dry there and blow away before discovered; some of the articles he uses or touches will come in contact with others or escape sterilization and get into general use. For these reasons those who have open tuberculosis should be segregated in places remote from thickly populated districts. Such treatment may seem harsh, but certainly is as necessary as segregation of lepers. Most persons having tuberculosis may arrest further development of the disease or recover completely by leading hygienic lives in the open air, and it should be made possible for them to do so.

Open-air existence together with proper food, clothing and work are effective preventatives of the disease. Those who lack them suffer most.

It has been established that children in open-air and cold-air schools, thrive better and work better than they formerly did, which seems to indicate the desirability of working in the open air as well as sleeping in it. All schools and work rooms should be constantly flooded with pure air.

A considerable number of cases of tuberculosis result from wearing the clothing, inhabiting the houses and sleeping in beds formerly used by tuberculous people. Bed bugs transmit the disease. Everything used by tuberculous persons, including the houses they live in, should be disinfected or destroyed by fire immediately after they are through with them. Such disinfection is one of the most efficacious means of limiting the spread of infectious diseases. Disinfection should be such that it destroys animals and insects which carry and implant disease germs as well as bacteria.

CHAPTER XIV.

DISINFECTION AND QUARANTINE.

DISINFECTION.

"Disinfection is that part of prophylaxis which has to do with the destruction of or modification of the exciting causes of disease." (Rosenberger).

We may define disinfectant as an agent capable of destroying the infective power of infectious material or an agent which brings about the destruction of bacteria in general and more particularly those that act as the exciting causes of disease. A disinfectant should also have the power of destroying the poisonous properties of toxins.

In a popular sense the term disinfectant is given a wider meaning than is indicated above, including not only the use of antiseptics and deodorants but also the actual removal of filth and all matter favorable to the growth or spread of disease germs, which latter is, strictly speaking, a matter of sanitation.

An Antiseptic is an agent retarding or arresting bacterial growth and consequent production of toxins or ptomains though not necessarily killing the bacteria; and though some antiseptics are germicidal others are not; therefore as a class they cannot be considered nor used as disinfectants.

A diluted germicide may act as an antiseptic.

Chlorinated lime is a good disinfectant in solutions of proper strength; added to a mass of sewage it may arrest further bacterial growth or action or prevent the filth from acting as a culture medium for disease germs even though totally inadequate in quantity to kill all the organisms present.

A deodorant is an agent that simply removes or destroys offensive odors and is not necessarily either disinfectant or antiseptic. Most deodorants check the action of saprophytic bacteria and consequent formation of putrefactive odors.

In practice it is well to remember, that while masses of dead organic matter may not in some cases contain disease germs and may even be hostile to them, in general the reverse is more likely to be true. Decomposing matter often furnishes a good field for the increase of pathogenic organisms.

Noxious gases given off to the air and the poisonous products added to drinking water from such masses may do much harm by depressing the system, lowering the vitality and acting as predisposing conditions to such diseases as cholera, yellow fever, typhoid and typhus fevers, and possibly diphtheria.

Where the removal of such filth is not practiced its power for harm should be checked permanently or at least temporarily by the use of disinfectants or antiseptics.

When actually dealing with disease germs disinfection to be trustworthy must be carried out to the best of our ability with the means at our command and with strict attention to the minutest details.

CLASSIFICATION OF DISINFECTANTS.

There are Thermal, Chemical, Mechanical and Physiological disinfectants. The secretions and tissues of the body which have the power of destroying infective matter are the physiological disinfectants.

The separation of micro-organisms from liquids by sedimentation or filtration, their removal from very smooth hard articles by wiping, and their removal from the human skin by thorough washing, constitutes mechanical disinfection.

Of thermal disinfectants Fire is the most efficacious but can only be used to disinfect non-combustible articles or those of little value which cannot be safely disinfected in any other way such as abandoned pest houses, books, old mattresses, pillows, etc.

Steam is the most practically efficient disinfectant. It is cheap, easily manipulated and less liable to injure articles than fire or hot air.

We employ it under pressure or in streaming state (live steam) the latter being as efficient as the former but requiring

a longer time. Steam at 240°F. kills the most resistant spores very quickly, while streaming steam at 212°F. may require an hour or two.

For surface disinfection streaming steam is relatively more efficient than superheated steam on account of the great liberation of latent heat when the former condenses, and possibly because the latter tends to dry rather than moisten micro-organisms thus rendering them harder to disinfect.

Special apparatus for disinfecting large articles by steam should be installed in cities and hospitals as a sanitary precaution and to prevent the spread of epidemics.

In steam sterilization, as with all other disinfectants, the aim must be to bring the germicidal agent into contact with every part of the affected matter, in other words secure thorough penetration. Steam under pressure is of course more penetrating than live steam and is especially expeditious when the apparatus is arranged so that air can be exhausted from it and a vacuum created in the interstices of the articles to be disinfected before the steam is introduced.

In large sterilizers constructed for hospitals or municipal use, every precaution is taken to prevent the reinfection of articles after they have been once sterilized. The sterilizing apparatus or autoclave is built into a wall which separates two rooms. The autoclave has an opening in each of the rooms. Material to be sterilized is collected by a corps of employes and carried in vehicles used for no other purpose and deposited in one of the rooms into which the autoclave has an opening. This is the receiving room and is never used for any other purpose; those who work in this room loading the sterilizer never handle the sterilized articles. When disinfection is complete the autoclave is emptied through the opening in the room opposite the receiving room. The disinfected articles are removed and delivered to their owners by a corps of employes and in vehicles that have no association with the collecting and receiving service.

BOILING POINT OF WATER UNDER STEAM PRESSURE.

Steam Pressure Lbs.	Boiling F.	Temperature C.
0	212	100
5	228	109
10	240	115.5
15	251	121.5
20	260	126.5
40	287	141.5

In the absence of spores bacteria are killed by hot water even below the boiling point. In the absence of chemical disinfectants boiling water may be used to disinfect excreta.

All clothing worn by the sick or their attendants should be boiled whether other disinfectants are employed or not.

Dry heat is less penetrating and less effective than moist and must be used at much higher temperatures for a longer time.

At 300°F. dry air requires at least three or four times as long to do what steam at 212°F. or 220°F. will do; moreover, it is apt to injure clothing or other organic material exposed to such high temperatures for so long a time as is necessary.

Fractional sterilization or disinfection may be resorted to where damage to goods is feared. By this method sterilization is produced by repeated exposure for short intervals.

Cold is not a positive germicide, or at best but a slowly acting one. Typhoid bacilli have been frozen for more than 100 days without losing their pathogenic property. Some bacteria have withstood the temperature of liquid air (—300°F.) for several hours or days. Intermittent freezing is harmful to the growth of bacteria and gradually kills them off. Living bacteria are found in abundance in cold storage chickens and meats.

Light, especially sunlight, is a valuable adjunct in the disinfection of rooms, clothing, etc., and should be used progressively throughout the course of an infectious disease in the sick room.

CHEMICAL DISINFECTANTS.

Most chemical disinfectants as employed are watery solutions or suspensions of metallic salts, mineral products or gases. A few are alcoholic solutions, and some are solids which give off noxious fumes during combustion.

They kill or destroy infective organisms chemically. Consequently, their effect depends upon several factors:

First, Length of time the disinfectant is in contact with infective organisms;

Second, Temperature at which the contact occurs;

Third, Physical and chemical properties of the medium in which the infective organisms exist:

Fourth. The amount of disinfectant and the number and nature of infective organisms.

In what is known as monomolecular reaction (which is that occurring between bacteria and disinfectant) the velocity of the reaction or the amount of change produced in unit time is directly proportional to the concentration of the reaction.

At low temperatures, disinfectants are much less active than at high temperatures. For every rise of 10° the efficiency of disinfectants is increased from two to ten-fold.

Disinfectants which are chemically incompatible with certain bacteria are useless as regards the destruction of those bacteria, e. g., antiformin and tubercle bacilli. Disinfectants which form inert salts or precipitate when they come in contact with substances such as albumin cannot affect bacteria situated in a medium containing such substances, e. g., bichloride of mercury and feces. Disinfectants which coagulate and make tissues impervious cannot permeate them, and consequently have no effect on organisms beyond the coagulated area, e. g., pure phenol and muscle tissue.

The greater the number of bacteria to be acted upon the greater the amount of disinfectant required.

At the presnt time the best method available, under ordinary circumstances, for the determination of the strength and value of disinfectants, is the method described by An-

derson and McClintic (Hygienic Laboratory Bulletin, No. 82, U. S. Pub. Health and Marine Hospital Service). A series of tubes containing 5 c.c. of various dilutions of substance to be examined, as dilutions of 1:100, 1:90, 1:80, 1:70, 1:60, 1:50, etc., have added to each of them 0.1 c.c. of 24-hour-old bouillon culture of bacillus typhosus. Every 2½ minutes up to 15 minutes sub-cultures are made from each of these tubes. The sub-cultures are incubated to find whether or not sterilization was effected.

At the same time a similai series of tubes, containing 5 c.c. of various dilutions of pure phenol, as 1:100, 1:90, 1:80, 1:70, 1:60, 1:50, etc., are treated in the same manner.

The disinfectant power of the substance under examination is compared with the disinfectant power of phenol, phenol being the STD. expressed as unity; then if the substance has only half the disinfectant power exerted by phenol its co-efficient is expressed as ½, or we say it has a co-efficient of 0.5. Likewise if the substance has five times the disinfectant power exerted by phenol its co-efficient is 5.

The original method of determining carbolic acid co-efficient, devised by Rideal and Walker and known as the Rideal-Walker method, is not as accurate as the method described by Anderson and McClintic.

The following chart from Hygienic Laboratory Bulletin, No. 82, Anderson and McClintic, illustrates the method of determining the co-efficient. Minus signs indicate that a loopfull of the mixture of typhoid bacilli and disinfectant transferred to 10 c.c. of sterile bouillon and incubated for 48 hours at body temperature showed no growth. The plus signs indicate that under identical conditions, growth occurred.

SAMPLE	DILUTION	Time culture exposed to action of disinfectant for minutes						PHENOL COEFFICIENT
		2½	5	7½	10	12½	15	
Phenol	1:80	—	—	—	—	—	—	$\frac{\frac{450}{80}+\frac{650}{100}}{2} =$
	1:90	+	—	—	—	—	—	
	1:100	+	+	+	—	—	—	
	1:110	+	+	+	+	+	+	
Chloro-Napholeum	1:400	—	—	—	—	—	—	$\frac{5.62+6.50}{2} = 6.06$
	1:450	—	—	—	—	—	—	
	1:500	+	—	—	—	—	—	
	1:550	+	—	—	—	—	—	
	1:600	+	+	—	—	—	—	
	1:650	+	+	+	—	—	—	
	1:700	+	+	+	+	+	+	
	1:750	+	+	+	+	+	+	

CHLORINE.

Chlorine is a greenish colored gas, 2½ times as heavy as air. It has a very strong affinity for hydrogen, and hence acts as an oxidizing agent, as a disinfectant, as a deodorant, and as a bleaching agent. Chlorine is a very irritating poisonous gas. Water will absorb nearly twice its volume of chlorine; moist slaked lime absorbs nearly one-half its weight of chlorine. Lime charged with chlorine is known as Chlorinated Lime, or more commonly as chloride of lime. It is a dry, white powder, having a peculiar odor. In the presence of moisture it deteriorates. As dispensed and used for disinfecting purposes chloride of lime. or bleaching powder, should contain at least 35% available chlorine. A saturated aqueous solution of chloride of lime is the form in which this disinfectant is commonly used, and such a solution should contain at least 1 per cent. by weight of available chlorine.

To determine whether a given sample of bleaching powder, or chloride of lime solution, contains chlorine, mix it with indigo or ordinary blueing and add a few drops of sulphuric acid. If chlorine is present the solution is bleached or decolorized.

One part of available chlorine mixed with two million parts of water will practically sterilize it, and does not affect it in any appreciable manner. This is a good method of treating swimming pools and other bodies of polluted water, and is extensively employed in the treatment of municipal water supplies, usually as an adjunct to sand filtration. It is added to the water in the form of calcium hypochlorite.

Chloride of lime or dilutions of it are used to disinfect sputum, urine, feces and other discharges; bed-pans, urinals, dishes, linen, drains, sewer pipes and utensils. Chlorine gas may be used to disinfect rooms, cars, other chambers and conveyances.

PHENOL.

Phenol (carbolic acid), according to Koch, is the best disinfectant for the cholera germ. In watery solutions of 1% to 5% strengths (preferably hot) phenol has been widely used in surgery. It is a valuable germicide, except for spores, and is frequently employed to disinfect sputum, urine, feces and other discharges, bed-pans, urinals, dishes, linen, drains, sewer pipes, etc.; also to wash floors, furniture and woodwork.

For the disinfection of sinks, urinals, water-closets, etc., a solution of from 1 to 5 parts of phenol and from 1 to 5 parts sulphuric acid mixed with 97 parts of water is most efficacious.

The Kresols—Metta, Para and Orth—closely resemble phenol in their disinfectant properties. A refined combination of the Kresols, known as Trikresol, is two or three times as powerful as phenol, and makes an efficient disinfectant in ½% to 1% solutions. It has the advantage of not coagulating albumen, and may be advantageously used in place of phenol. All Kresols are more poisonous than phenol and should be labeled accordingly.

Creolin is not as efficient a germicide as formerly believed. It is much weaker than phenol and should be used, if at all, in from 2% to 5% solutions. It requires very thorough shaking, stirring or mixing immediately before use.

BICHLORIDE OF MERCURY.

Bichloride of Mercury is an efficient and widely-used disinfectant. As it corrodes metals, it cannot be employed in the disinfection of sinks, drains or metallic utensils. Hot, aqueous solutions of corrosive sublimate, in the strength of from 1:500 to 1:100, is excellent for scrubbing floors and other woodwork, but one's hands require the protection of rubber gloves while working with such strong solutions.

The coagulation of albumin can be prevented by adding to bichloride solutions 1% of citric acid, tartaric acid, ammonium chloride or sodium chloride. The same result can be obtained by adding one part of H_2O_2 (15% sol.) to three parts of bichloride solution.

Calcium hydrate, mixed with water to make thin whitewash (Milk of Lime) is said to be a good disinfectant, especially for excreta. It is cheap and easily prepared. When used it should be added to infective matter in excess or until the mixture is decidedly alkaline. It requires one or two hours to disinfect thoroughly. Used in the treatment of cesspools the technique is as follows: Mix 1 part of lime with 4 parts of water, and of this add 2 quarts per day for each individual using the cesspool.

Antiformin, a mixture of liquor sodii chlorata and sod. hydrate, when coming in contact with bacteria, occasions vigorous oxidization and liberation of active oxygen, completely destroying all known bacteria except the tubercle bacillus and other acid-resisting organisms in 5% and stronger solutions.

FORMALDEHYDE.

Formaldehyde (Formic Aldehyde) is one of the best disinfectants now in use. It possesses considerable penetrating power, although less than steam. For surface disinfection it acts almost immediately, much better than sulphur or chlorine. Clothing, rugs, hangings, etc., are quickly sterilized by freely exposing them to it. When employed to disinfect a room, bedding, mattresses and pillows are the only objects that need be removed for other treatment. It neither bleaches nor injurs clothing or furniture and is virtually non-poisonous,

but is irritating to the conjunctiva and other mucous membranes. Formaldehyde is readily soluble and held in solution by water to the extent of 40%, by weight of the latter, but when this proportion is exceeded there is a polymerization of the gas and a solid (Paraform or Paraformaldehyde) is precipitated, which is only resolved again into formaldehyde at a temperature of 275°F.

The 40% solution is practically identical with the preparation known commercially as formalin, which has usually an addition of 10% methyl alcohol to further guard against precipitation. Weak solutions of the gas (1 to 2%) are still effectively disinfectant, while its virtue as an antiseptic persists even when the dilution is carried to a remarkable degree.

One peculiar effect of formaldehyde solutions is that of rendering connective tissue and all gelatinous substances insoluble in either hot or cold water; probably to this its germicidal activity is largely due since the food supply of bacteria, if not the bacteria themselves, is partly of this nature. It also irritates and roughens the skin.

One of the first and best methods of liberating formaldehyde in rooms and buildings was the heating and vaporizing of a solution of the gas such as formalin or formochloral, the latter, a mixture of formalin with calcium chloride, calcium chloride being added to insure against precipitation of paraform.

Trillats' apparatus consists of a regenator which allows formochloral to flow in a fine stream through a copper coil heated to redness by a flame, the gas vapor then passing directly into the room in a superheated and effective condition.

In the Novy Waite and Trainer Lee generators there is special provision for the rapid evolution of gas at a high temperature. Both of these generators can be operated outside the room to be disinfected.

In the Sherring Method solid paraform is heated in a receptacle over an alcohol lamp. The volume of resulting formaldehyde depending of course upon the amount of paraform used. This method is of especial value in disinfecting small rooms, closets and sterilizing cases for instruments, dressings, etc.

Spraying formalin from a compressed air or steam atomizer or by evaporating from saturated sheets hung about the room is not a certain method of liberating gas, and hence necessitates the use of large quantities of solution.

The Kuhn Generator is an apparatus in which alcohol vapor passes between two cones of heated platinized asbestos, one of which is so arranged as to act as a deflector, preventing extreme and concentrated heat being thrown directly on the surface of the vessel containing the wood alcohol. Any alcoholic vapor escaping the action of these platinized cones passes through five disks or layers of platinized wire (no. 20 mesh or 400 meshes per sq. inch). In this way alcohol is brought into thorough contact with platinized surface and the result is nearly complete conversion into formaldehyde.

A most efficient method of disinfecting with formaldehyde is generation of the gas within an autoclave set to blow off at 45 pounds pressure. The apparatus is set up outside the room or compartment to be treated and a hose attached to the autoclave delivers formaldehyde laden steam through a keyhole or other opening.

Formaldehyde is conveniently liberated by pouring one pound of formalin on six ounces of permanganate of potassium—this amount for each 1000 cubic feet of space, or fraction thereof, to be disinfected. Some use 20 ounces of formalin and 16 ounces of permanganate.

When formalin alone is used from 10 to 30 ounces per 1000 cubic feet must be allowed. Some have used formalin or formaldehyde in combination with other disinfectants such as sulphur, lime, phenol and glycerin. In whatever form it is employed the atmosphere of the room to be disinfected should be moist, to enhance the germicidal activity; the room should be warm, its temperature as high or higher than that of adjoining compartments.

Bromine is an insecticide as well as a germicide but is so poisonous as to be too dangerous for ordinary use.

Sulphur dioxide (SO_2) is germicidal to sporeless bacteria and an efficient insecticide, used in the proportion of at least 3 pounds per 1000 cubic feet of space. Its use entails less

risk and trouble than chlorine but it bleaches, tarnishes and destroys fabrics, hence its employment is limited.

When a room is to be disinfected, bedding should be removed and either sterilized in an autoclave or boiled or burned. It is desirable to remove carpets, draperies, curtains, portiers, and pictures, in short have the room bare as possible, when these things can be properly treated outside; if they cannot, then they should not be removed but hung over clothes lines stretched across the room so that fumigation will permeate all parts of all the things. Closets and drawers should be opened and their contents spread out over clothes line. Seal all cracks and crevices with cotton, paper or adhesive plaster to keep the gas within the room. Leave the room exposed to the action of the disinfectant at least six or eight hours. Then open every window and door, admit the sunshine and thoroughly air because it is necessary to rid the room of formaldehyde and other disinfectants before the room is again inhabited, as such agents injure the mucous membranes and endanger health. After airing the room the woodwork and other washable parts should be cleansed with a hot solution of some soapy disinfectant such as lysol, kresol or creolin.

Sick room disinfection should progress throughout the time a patient having an infectious or contagious disease inhabits it; feces, sputum and urine should be received at the bed-side in receptacles containing germicides and they should be thoroughly disinfected before discharging into drains. Strong solutions of lye or sodium hydrate may be used. Windows and doors should be guarded against the entrance of flies and mosquitoes.

Tests should be made to determine whether disinfection has been complete. For this purpose cultures of organisms suspended on threads, or pieces of filter paper or crinolin are put into small boxes (pill boxes) with perforated lids, these are placed in different parts of the room and at different heights. When the room is opened after fumigation these boxes are removed and their contents placed in bouillon culture medium (two changes) this is kept under observation for several days so that bacterial growth may be detected should it occur.

It has been found by practical experience that fumigation is unnecessary after measles, diphtheria, scarlet fever and typhoid fever.

QUARANTINE.

Quarantine is a derivative of quarante, meaning forty, the number of days' detention to which vessels and their personnel, arriving from places infected with plague, were at one time detained in French ports. The custom or maritime quarantine was first instituted in Venice, in 1403. Today quarantine embraces a great number of procedures intended to prevent, limit and eradicate disease, among the commonest of which are routine inspection, disinfection and detention of common carriers and their passengers, crews and cargoes. National or Federal quarantine is that exercised by the National Government to prevent the introduction of diseases from other countries, and the spread of disease from one State to another by means of interstate quarantine.

State quarantine is that exercised by a single State for the protection of its own citizens and municipal is that exercised within a city by municipal authority. Port or maritime, interstate and railroad quarantine are intricate and involve such a vast amount of detail that we cannot consider them here.

House quarantine should be enforced where there is small-pox, scarlet fever, diphtheria, cerebro-spinal meningitis, cholera, typhus, typhoid fever, yellow fever, relapsing fever, leprosy or plague. The procedure varies according to the disease, locality and status of the individuals affected. In the United States and most other countries the methods regulating house quarantine are not as good as we might reasonably expect; frequently they are too lax and often unnecessarily severe.

When one of the occupants of a house is afflicted with diphtheria, if he is immediately removed to a hospital, it is common practice to disinfect the house and free other occupants of the house from quarantine, provided they show no clinical signs of the disease. It would be much safer to determine that the persons who lived in the same house with a

diphtheria patient did not harbor the diphtheria bacillus before releasing them from quarantine. Where one of the occupants of a house develops diphtheria and remains in the house, the general method of quarantine is about as follows:—A conspicuous sign is attached to the building informing the public of the fact that diphtheria lurks within, warning them of the danger of entering or prohibiting them to enter. Inmates of the house other than the afflicted are permitted to go out and in at will but are forbidden to attend theatres, churches and other public gatherings and are excluded from schools, but they are not forbidden use of public conveyances such as cars and boats. It is unusual to examine these contacts for diphtheria bacilli before granting them what is practically freedom from quarantine. The person who had the disease is not permitted to leave the house and the quarantine is not lifted until two negative cultures, whether negative or positive being determined by microscopic examination only, have been obtained on two consecutive days. This is an unfortunate and often reprehensible practice. It is a well-known fact that many persons carry in their throats non-pathogenic bacteria that are microscopically indistinguishable from the diphtheria bacillus, and they may harbor these non-pathogenic bacteria continuously for many months. By inoculation into guinea pigs, diphtheria bacilli can be differentiated from similar non-pathogenic organisms. Since it is possible to distinguish these organisms biologically and impossible to distinguish them microscopically, the biological test should be resorted to before depriving an apparently healthy person of liberty.

In the exanthemata, quarantine is usually raised two weeks after the eruption has entirely disappeared, excepting small-pox, for which the period is thirty days.

Those exposed to the infectious diseases are detained until after the period of incubation of the particular disease has elapsed; that is: Small-pox, twelve days; Typhus, twelve days; Typhoid Fever, fourteen days; Cholera, ten days; Measles, ten days; Plague, seven days; Yellow Fever, five days; Scarlet Fever, three days; Diphtheria, three days.

It is customary to vaccinate all persons exposed to small-pox before releasing them, and this practice sometimes makes

necessary the establishment of detention camps or the posting of a sanitary cordon, an extended line of guards who surround a district and prevent access or egress.

A person confined in a house, suffering with any infectious disease should remain in a room as much isolated from others as possible; a room that other occupants of the house do not have to pass.

Houses in which there have been cases of infectious diseases are disinfected before they are released from quarantine.

At the present time patients suffering with typhoid fever who come under the care of the U. S. Marine Hospital Service are kept in quarantine until successive examinations of both urine and feces show absence of typhoid bacilli. In this way the public is protected from carriers.

Dissemination of Bacteria and Animal Parasites by Insects, Rodents, etc.

Poliomyelitis	Stomoxys Calcitrans (Stable Fly) (?)*
Typhoid Fever	Flies, Roaches, Bed-bugs.
Typhus "	Louse
Tuberculosis	Flies, Bed-bugs, Cattle
Leprosy	Flies, Bed-bugs, Mosquitoes (?)
Anthrax	Flies, Cattle
Bubonic Plague	Fleas, Rats, Squirrels, other rodents, Fowls
Glanders	Flies, Horses, Wild Animals
Trachoma (Egyptian)	Musca domestica (?)
Asiatic Cholera	Flies
Malaria	Mosquito (Anopheles)
Kala Azar	Mosquito (Anopheles) (?)
Yellow Fever	Mosquito (Stegomyia Calopus)
Filariasis	Mosquito (Anopheles, Culex pipiens)
Trypanosomiasis	Tse-tse Fly
East Coast Fever	Mosquito
Rocky M'ntain Fever	Ticks Rhipicephalus Annulatus
Texas Fever	Ticks
Myiasis	Musca domestica
Screw Worm	Lucilia macellaria
Malta Fever	Goat's Milk containing micrococcus melitensis.
Summer Diarrhoea of children	Milk contaminated by flies
Relapsing Fever	Mosquito (?)
Ova of Tapeworms	Carried by flies deposited on food
Rabies	Dogs

*(?) Indicates that the suspected carriers have not been proved such.

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